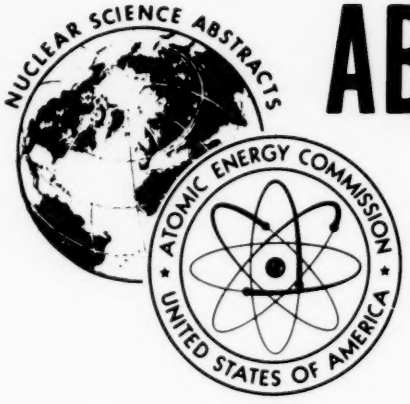
NUCLEAR SCIENCE ABSTRACTS



Volume 25 Number 21

Abstracts 48433-51357

November 15, 1971

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Volume 25, Number 21, November 15, 1971

NUCLEAR SCIENCE ABSTRACTS

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separation by ion exchange and complex-formation elution, 25:251(P)

TRIETHYLENETETRAMINE
complexes with cobalt(III) and rhodium(III) chlorides, radiation effects on labeled, thermal-neutron, 25:137
TRITIUM
content in Cattaraugus Creek near West Valley Processing Plant, July through Dec. 1969, 25:258 (DOCKET-50201-48)
content in Cattaraugus Creek near West Valley Processing Plant, Jan. to July 1970, 25:259 (DOCKET-50201-49)
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372 (UCRL-72739) CONSTRUCTION OF A UNIQUE UNDERGROUND WHOLE BODY COUNTER. Griffith, R. V.; Anderson, A. L.; Lindeken, C. L. **(California Univ., Livermore. Lawrence Radiation Lab.).** Oct 1970. 27p. (CONF-701009-1). Dep. NTIS.

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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 48786, 48796, 48797, 48879, 48924, and 51075.

48433 (ANL-Trans-886) CHEMICAL ANALYSIS. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Argonne National Lab., Ill., from Section 1, pp 5-93 of report CEA-N-1341. 83p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 25: 6260. (J.G.B.)

Chemical and Spectral Procedures

Refer also to abstract 48586.

48434 (CONF-710617-22) CALORIMETRIC DETERMINATIONS OF PLUTONIUM IN BULK REACTOR MATERIALS. O'Hara, F. A.; Nutter, J. D.; Rodenburg, W. W. (Mound Lab., Miamisburg, Ohio). 7 Jun 1971. Contract AT(33-1)-Gen-53. 27p. Dep. NTIS.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

Bulk samples from various points in the nuclear fuel cycle were analyzed for plutonium using calorimetric techniques. The samples included plutonium oxide feed material, lots of mixed oxide pellets, experimental fuel pins and platelets, and scrap and fired combustibles. Plutonium content ranged from 5 grams to 1 kilogram. The calorimetric system utilized and a typical sample run are described. Details of the calculations performed are explained. Reliance on other data and their limitations are discussed. Precision and accuracy were 0.6% and 1.4%, respectively, at 5 grams plutonium and 0.02% and 0.1%, respectively, at 1 kilogram. A technique to reduce shipper-receiver errors below 0.1% is described. (auth)

48435 (K-1818) MASS SPECTROMETER ANALYSIS OF NEON ISOTOPES. Horton, J. C.; Langdon, A.; Sulfridge, C. (Oak Ridge Gaseous Diffusion Plant, Tenn.). 13 Aug 1971. Contract W-7405-eng-26. 10p. Dep. NTIS.

A 6-in.-radius, 60° sector, dual-collector mass spectrometer was modified for precise ratio measurements of neon isotopes. A bellows was attached to the manifold to regulate the sample pressure behind the leak and thus avoid leak adjustments between samples being compared. An expanded-scale meter was added to the dc amplifier to facilitate precise setting of the ion beam intensity by regulating the manifold pressure with the bellows. With ratios of isotopic ratios of 1.04, the standard deviation of a single determination was ±0.0001. (auth)

48436 (RT/CHI-(70)43) ANALYSIS OF MICRO CONSTITUENTS IN Zr MATRIX. II. SIMULTANEOUS COULOMETRIC DETERMINATION OF Cu AND Fe WITHOUT PRELIMINARY SEPARATION. Guidotti, G. R.; Borello, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 26 Nov 1970. 26p. Dep. NTIS (U. S. Sales Only).

Cu and Fe contained in 1% Cu-0.4% Fe-Zr alloys of nuclear interest as fuel jacketing material can be determined by constant electric tension coulometry without preliminary separation. Zr alloy is dissolved with 9 M H_2SO_4 in the presence of HNO_3 and HF as catalyst. After evaporation to copius fumes of SO_3, the residue is diluted with 0.5 M H_2SO_4-0.5 M Na_3 cit. aqueous solution to a known volume. The method suggested involves the reduction of Cu(II) to Cu(Hg) and of Fe(III) to Fe(II) on a Hg pool electrode at -0.25 V vs. S.C.E. in 0.5 M H_2SO_4-0.5 M Na citrate. The re-oxidation of Cu(Hg) to Cu(II) is then accomplished at +0.05 V after complexing Fe(II) with 1,10-phenanthroline. The relative average error at 95% confidence level is ±0.5% and ±1% for Cu and Fe, respectively. (auth)

48437 (RT/CHI-(70)45) REPRODUCIBILITY AND ACCURACY IN MASS-SPECTROMETRIC ANALYSES OF URANIUM COMPOUNDS BY THERMAL IONIZATION. Siciliano, F.; Fedeli, V. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 30 Nov 1970. 19p. Dep. NTIS (U. S. Sales Only).

The reproducibility problem for the isotopic ratio determination and the calibration and the available accuracy linked to many parameters involved with thermal ionization source mass spectrometers are discussed on a semi-quantitative basis. The results of NBS standards are also given. The uranium isotopic ratios determined $R_{58} > 1$ are in the same order of magnitude of the uranium isotopic ratios R_{5x} (X = 3, 6, 8, i.e., ^{233}U, ^{236}U, ^{238}U) of fuel elements samples that will be reprocessed in ITREC plant. (auth)

48438 DETERMINATION OF SMALL QUANTITIES OF EUROPIUM. Fabian-Mohai, M.; Upor, E.; Nagy, Gy. (Mecsek Ore Mining Co., Pecs, Hungary). Acta Chim. Acad. Sci. Hung.; 68: No. 1-2, 1-9(1971).

A method has been developed for the determination of small amounts of europium. Two of the three variations are based on the luminescence described by Poluektov; however, selective sodium amalgam separation of europium has made possible the use of Arsenazo III reagent for the determination of the europium content of samples containing high quantities of rare earths. Interfering contaminations are separated by oxalate precipitation and extraction of rare earths with dibutyl phosphate followed by re-extraction under special conditions. The following sensitivities were obtained for the three methods: $1 \cdot 10^{-5}$% (fusion, luminescense), $2 \cdot 10^{-4}$% (o-phenanthroline + atophane), and $1 \cdot 10^{-3}$% (Arsenazo III). After accomplishment of the separations described, the solution obtained is suitable for any of the three types of analysis. These methods are suitable for the determination of the europium content of monazite, apatite, various rocks, and compounds of rare earths. (auth)

48439 STUDY OF SOME CATIONS INTERFERENCES IN THE PRESENCE OF $TiCl_3$ ON THE NIOBIUM POLAROGRAPHIC REDUCTION IN HCl-THIOCYANATE MEDIUM. Marchidan, Sofia; Dragulescu, C.; Facsko, Gh. (Centre of Physical Chemistry, Bucharest). Rev. Roum. Chim.; 16: No. 6, 813-21(Jun 1971).

For removing or diminishing the interferences occurring in the polarographic determination of niobium in HCl-thiocyanate-acetone medium, the influence of some cations was studied in the presence of reducing or complexing agents that might affect the formation or polarographic reduction of the respective thiocyanates. In the presence of $TiCl_3$ the interference of vanadium is completely removed, that of iron is brought to a constant value independent of its concentration in solution, and tungsten interference is diminished. Thus, in the 10^{-4} to 10^{-3}M concentration range niobium may be determined in the proposed medium in the presence of the most frequent elements that accompany it. (auth)

48440 SPECTROMETRIC ANALYSIS OF ^{15}N IN THE PRESENCE OF BORATE. Blohm, D.; Irmler, R. Humboldt-Univ., Berlin). Isotopenpraxis; 7: No. 4, 149-50(Apr 1971). (In German).

Solutions of ^{15}N-labeled ammonium chloride were mixed with solutions of various borate content, up to 1:100. The mixtures then were treated with CuO and CaO, and spectrographically measured. Results showed that the borate concentration in samples has no effect on the ^{15}N measurement. (H.B.G.)

48441 SEMI-QUANTITATIVE ANALYSIS BY MEANS OF THE LASER MICROPROBE. Webb, M. S. W.; Webb, R. J. (Atomic Energy Research Establishment, Harwell, Eng.). Anal. Chim. Acta; 55: No. 1, 67-75(Jun 1971).

Conventional methods of quantitative spectrochemical analysis cannot, in general, be applied to spectra produced by the laser microprobe. An alternative procedure is given for quantifying the recorded spectra from the laser/spark excitation of any type of material, thus providing a complete survey analysis of the metallic constituents of the sample or part of the sample under examination. No systematic bias has been observed in the accuracy of the results obtained; results below 10% were within a factor of two of the nominal figure and were considerably better at higher concentrations. (auth)

48442 DETERMINATION OF VARIOUS IMPURITIES IN PLUTONIUM BY ATOMIC ABSORPTION. Vienney, J. (Centre d'Etudes de Bruyeres-le-Chatel, Montrouge, France). Anal. Chim. Acta; 55: No. 1, 37-46(Jun 1971). (In French).

Atomic absorption spectrophotometry is applied for the rapid determination of 21 trace elements in plutonium without preliminary separation. A suitable arrangement to avoid atmospheric contamination is described. An extensive study of interferences has been made. (auth)

48443 PHOTOMETRIC DETERMINATION OF SILVER AND MERCURY WITH GLYOXAL DITHIOSEMICARBAZONE. Budesinsky, B. W.; Svec, J. (Univ. of Waterloo, Ont.). Anal. Chim. Acta; 55: No. 1, 115-24(Jun 1971).

Glyoxal dithiosemicarbazone forms hypsochromic complexes of ML with silver(I), mercury(II), copper(II), and palladium(II); the logarithmic overall stability constants are 28.1, 23.6, 22.5, and 23.2, respectively. The complexes are formed in the pH interval 1.0 to 7.0. Complexes of silver(I) and mercury(II) may be used for the photometric determination of these elements at pH 1.1 ± 0.1 in the presence of EDTA. Effective molar absorptivities are 43,000 and 44,000 cm^2 $mmole^{-1}$ at 335 nm. Of 30 cations and 15 anions studied, only bromide, iodide, thiocyanate, and thiosulfate interfere at molar ratios of 2.5 to 5 for 0.2 μmole of silver(I) or mercury(II). Other ions usually interfere only above the molar ratio 150. With regard to mutual interference of silver(I) and mercury(II), silver(I) may be masked by chloride so that the determination of mercury(II) is possible up to the molar ratio 10. (auth)

48444 CURRENTLESS ENRICHMENT POSSIBILITIES OF TRACE METALS ON THE MERCURY–ELECTROLYTE INTERFACE. PART II. ADSORPTIVE ENRICHMENT STUDIES ON THE DROPPING MERCURY ELECTRODE WITHOUT USE OF SURFACE-ACTIVE COMPLEXING AGENTS. TRACE DETERMINATION OF URANIUM AND TUNGSTEN. Berge, H.; Ringstorff, H. (Univ., Rostock, Ger.). Anal. Chim. Acta; 55: No. 1, 201-8(Jun 1971). (In German).

Traces of uranium and tungsten can be concentrated at a stationary mercury electrode at zero current. The determination of these metals in presence of each other, and in presence of other heavy metals is discussed. The effects of pH, concentration potential, speed of polarization, and concentration of electrolytes and surfactants on peak currents are described. (auth)

48445 DETERMINATION OF ZIRCONIUM IN GLASSES, GLASS-CERAMICS, AND REFRACTORIES WITH p-BROMOMANDELIC ACID. Su, Yao-sin; Campbell, D. E. (Corning Glass Works, N. Y.). Anal. Chim. Acta; 55: No. 1, 265-8(Jun 1971).

The application of p-bromomandelic acid to the determination of zirconium in glasses, glass-ceramics, refractories, and minerals, presents some special problems owing to the complexity of matrices involved and the difficulties attending their decomposition. A procedure is described that effectively circumvents most of the problems associated with the accurate determination of zirconium in these materials. (auth)

48446 DETERMINATION OF GERMANIUM AND MOLYBDENUM IN COAL. Nurminskii, N. N. Tr. Irkutsk. Politekh. Inst.; No. 44, 148-55(1970). (In Russian).

The ground sample is mixed with K_2SO_4, $CuSO_4$ and H_2SO_4, and the mixture is boiled until decomposition is complete, then diluted to a known volume. Separate aliquots are used for the determinations of Ge and Mo. The Ge is separated from interfering elements by extraction (as $GeCl_4$) into CCl_4, and re-extracted into water; alternatively, Ge is coprecipitated with $Fe(OH)_3$; the precipitate is ignited at ≈550°; and the residue is distilled with HCl and H_3PO_4, the volatile $GeCl_4$ being collected in water. The Ge in either aqueous solution is determined photometrically with phenylfluorone. The Mo is determined photometrically as its complex with SCN^- (Referativnyi Zh.)

48447 BENZENE-, METHANE-, AND ETHANESULFONYLBENZAMIDE OXIMES AS REAGENTS FOR THE PHOTOMETRIC DETERMINATION OF RUTHENIUM(VI). Klimkovich, E. A.; Usatenko, Yu. I.; Fedorova, N. G. (Dnepropetrovsk Chemical Tech. Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol.; 14: No. 3. 346-9(1971). (In Russian).

Certain sulfonylamide oximes selectively react with Ru(VI) with the formation of blue or red complexes, but do not react with Ru(IV) or with the other members of the Pt group of metals. The anion RuO_4^{2-} gives rise to a blue complex, and either $[RuO_3Cl_2]^{2-}$ or $[RuO_2Cl_4]^{2-}$ forms a red complex, the latter taking place in moderate concentrations of HCl. Three derivatives of $R-SO_2-NH-C(:NOH)C_6H_5$, where R represents phenyl, methyl, or ethyl, were tested with 8×10^{-5} mole/l Na_2RuO_4 solution. On the basis of the experimental data, it was concluded that benzenesulfonylbenzamide oxime is the preferred photometric reagent for Ru(VI). The complexes may be extracted with a 1:1 mixture of butyl alcohol and $CHCl_3$. (K.S.W.)

48448 INCREASING THE SENSITIVITY OF THE DIRECT SPECTROGRAPHIC DETERMINATION OF MICROIMPURITIES IN NIOBIUM PENTOXIDE. Moroshkina, T. M.; Kovrizhnykh, V. M.; Mel'nikov, Yu. A. (Leningrad State Univ.). Zh. Anal. Khim.; 26: No. 7, 1352-4(Jul 1971). (In Russian).

A method is suggested for the direct spectrographic determination of aluminum, titanium, nickel, iron, zirconium, cobalt, vanadium, chromium, tantalum, and manganese in niobium pentoxide with a sensitivity of 3×10^{-5} to 1×10^{-2}% and a mean square error of 20 and 6%, respectively. (auth)

48449 ANALYTICAL CHEMISTRY OF URANIUM(III). COMMUNICATION 1. OXIDIMETRIC DETERMINATION OF URANIUM AFTER ITS REDUCTION TO URANIUM(III). Nemodruk, A. A.; Poloznikova, E. I.; Myasoedov, B. F. Zh. Anal. Khim.; 26: No. 7, 1336-9(Jul 1971). (In Russian).

A study was made of the reduction of uranium(VI) to uranium(III) with amalgamated zinc in the Jones reductor and with zinc amalgam in the Nakazono reductor. Conditions were found for the quantitative reduction of uranium(VI) to uranium(III). Uranium can be determined with a reasonable accuracy if the solution coming out of the Jones reductor is taken directly into a receiver containing a standard potassium bichromate solution, and then the excess of chromium(VI) is titrated with a thiosulfate solution. (auth)

48450 USE OF N-CINNAMOYLPHENYLHYDROXYLAMINE IN ANALYTICAL CHEMISTRY. COMMUNICATION 3. JOINT PRECIPITATION OF TITANIUM AND ZIRCONIUM AND THEIR SEPARATION FROM IRON, ALUMINUM, AND CHROMIUM. Ostroumov, E. A.; Kulumbegashvili, V. A. (Inst. of Oceanology, Moscow. Tbilisi State Univ., USSR). Zh. Anal. Khim.; 26: No. 7, 1318-21(Jul 1971). (In Russian).

A study was made of the precipitation of titanium and zirconium with N-phenylcinnamohydroxamic acid when they are present together. A method was developed for the joint precipitation and determination of the total TiO_2 and ZrO_2. A method is suggested for the joint separation of titanium and zirconium from iron, aluminum, and chromium which ensures a complete separation with a single precipitation. (auth)

48451 EXTRACTION OF THE RARE EARTH ELEMENTS AS THREE-COMPONENT COMPLEXES WITH ε-CAPROLACTAM. Eremin, Yu. G.; Volkova, I. I. (Kalinin Polytechnical Inst., USSR). Zh. Anal. Khim.; 26: No. 7, 1310-12(Jul 1971). (In Russian).

A method was developed for extracting the rare earth elements as iodine complexes of hexa-ε-caprolactam lanthanides with a mixture of tributyl phosphate and isoamyl alcohol. The method was used for determining the rare earths in peat using Arsenazo III and photometry. (auth)

Isotope Dilution Procedures

48452 PHYSICO-CHEMICAL PROCESSES DURING THE DETERMINATION OF OXYGEN IN METALS BY THE ISOTOPE-DILUTION METHOD. COMMUNICATION 1. A STUDY OF THE KINETICS OF GAS LIBERATION. Saksonova, L. N.; Maksimov, D. I.; Burtsev, V. T. (Inst. of Metallurgy, Moscow). Zh. Anal. Khim.; 26: No. 7, 1360-5(Jul 1971). (In Russian).

The rate of gas liberation was studied by the method of con-

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tinuous recording of the intensity peaks ^{28}I and ^{30}I on the determination of oxygen in Ni, Nb, and Mo, and also in Mo with dispersed La_2O_3 oxides. The equilibrium distribution of ^{18}O in the system gas–melt was attained in 2 to 4 min after putting the sample into the bath melt. The variation of $I^{12}C^{16}O$ and $I^{12}C^{18}O$ during 40 min exposure was found. (auth)

Radiometric and Radiochemical Procedures

Refer also to abstracts 48923, 48925, 48952, and 49203.

48453 DETERMINATION OF ^{90}Sr ON IONEX COLUMNS IN MILK AND BONES WITH REGARD TO THE COMPLEXING PROPERTIES OF SOME REAGENTS. Zima, S. (Veterinaermedizinische Hochschule, Brno); Giacintov, P. J. Radioanal. Chem.; 7: No. 1, 19-27(Jan 1971). (In German).

The determination of ^{90}Sr is extremely difficult in biological materials by chemical methods owing to the quantity of calcium present. The problem consists of the quantitative removal of calcium and of the selective extraction of ^{90}Sr using strontium carrier. It can be solved by precipitation and extraction methods, or by ion exchange chromatography. Experimental evidence is presented using an ion exchange technique for these purposes, where complex compounds are used as eluents for calcium removal. For the determination of ^{90}Sr in milk and bones, calcium was removed with 1,2-diaminocyclohexane-N, N, N', N'-tetraacetic acid (CyDTA) eluent from Amberlite IR-120 column. Results show that compounds of chelatone type used as eluents with a strong acidic cation exchanger column are the most convenient, since they prefer to compound with ligands of weaker or mean complexibility (hydrochloric acid, citric acid, and lactic acid). (auth)

48454 RADIOCHEMICAL DETERMINATION OF FORMALDEHYDE IN FIBROUS MATERIAL. Roesseler, M.; Paul, D.; Groebe, A. (Zentralinstitut fuer Isotopen- und Strahlentechnik, Leipzig). J. Radioanal. Chem.; 7: No. 1, 49-55(Jan 1971). (In German).

Radiochemical analysis using ^{14}C-labeled formaldehyde was applied to detect reliably the amount of formaldehyde proportional to the activity in viscose rayon, spun in a formaldehyde-containing spinning bath by using an ionization chamber assay. The objects investigated were found to contain 2×10^{-5} mg to 1.4×10^{-4} mg formaldehyde, the relative error being lower than 4%. The scope of application of this method is discussed. (auth)

48455 DETERMINATION OF THE ISOTOPE RATIO $^{234}U/^{238}U$ WITH A SCINTILLATION α-SPECTROMETER. Szy, D.; Sebessy, L.; Balint, G. (Ore Mining Enterprise of Mecsek, Koevagoszoelloes, Hungary). J. Radioanal. Chem.; 7: No. 1, 57-65(Jan 1971).

A method was developed for the determination of the isotope ratio $^{234}U/^{238}U$. The preparation of the radiation source and a procedure based on the scintillation measurement of the α-spectrum are described. The results are compared with data of the $\alpha-\beta$ method used earlier. A few isotope ratios obtained in the examination of natural waters are presented for comparison. The results show the advantages of the application of the simple scintillation α-spectrometer and the justification of its use for $^{234}U/^{238}U$ serial measurements. (auth)

48456 EXPERIMENTAL EVALUATION OF SOME FACTORS THAT INFLUENCE THE DETERMINATION OF ^{90}Sr IN MILK AND BONES BY THE PRECIPITATION PRINCIPLE. Zima, S. (Veterinaermedizinische Hochschule, Brno); Giacintov, P. J. Radioanal. Chem.; 7: No. 1, 9-18(Jan 1971). (In German).

A survey is given on the basic factors affecting the determination of ^{90}Sr in milk and bones by removal of the excess calcium by precipitation. Strong co-precipitation of calcium and strontium takes place using fuming nitric acid, potassium hexacyanoferrate, EDTA, ethanol–ether mixture and butanol-(1) due to partial precipitation, recrystallization and adhesion processes where the pH value of the environment plays an important role. The obtained results show very limited applicability of these agents for the determination of ^{90}Sr in biological materials because of low accuracy and reproducibility. This conclusion is especially valid for the method of rapid determination of ^{90}Sr with EDTA. A method is given for the determination of ^{90}Sr in milk and bones using potassium hexacyanoferrate. (auth)

48457 TENTATIVE METHOD OF ANALYSIS FOR TRITIUM CONTENT OF THE ATMOSPHERE. Health Lab. Sci.; 8: No. 2, 107-10(Apr 1971).

Air is pumped at a sampling rate of approximately 100 to 150 cm^3/min through a silica gel column which collects moisture from the air. This flow rate is sufficient for continuous sampling. Other methods of moisture collection such as cold traps or dehumidifiers are also suitable for short-term sampling. The collected moisture sample is then removed from the column or collection device and is analyzed for tritium. A suitable volume of collected moisture is mixed with scintillation solution, and the mixture counted in a liquid scintillation beta counter. The air flow rate and the total volume of moisture collected during the sampling period, or the absolute humidity, are determined in order to convert the concentration of tritium in the collected moisture sample to its concentration in air. For long sampling periods the determination of air flow rate is more convenient than humidity measurements. (auth)

48458 DETERMINATION OF GOLD BY PRECIPITATION WITH ^{51}Cr-LABELED REINECKE SALT. Ilica, D. D. Rev. Chim. (Bucharest); 21: No. 7, 417-19(Jul 1970). (In Rumanian).

The Reinecke salt $[Cr(SCN)_4(NH_3)_2]NH_4$, one of the few inorganic substances to precipitate Au^+, may be labeled with ^{51}Cr and used to determine gold. The radiometric method was found to extend the lower limit of determination of gold with Reinecke salt to 0.02 mg, improving considerably the gravimetric technique, the limit of sensitivity of which is 2.5 mg. The proposed method may be used to determine gold in alloys in which it may be separated from silver. It may be adapted to automated handling, replacing the weighing operations by activity measurements. (JPRS)

48459 DEOXYRIBOKINASE FROM SALMONELLA TYPHIMURIUM: PURIFICATION AND PROPERTIES. Schimmel, Steven David. New York; Yeshiva Univ. (1969). 180p. University Microfilms Order No. 71-6018.

Thesis.

Deoxyribokinase, which catalyzes the ATP-dependent phosphorylation of 2-deoxy-D-ribose as the first step in the inducible fermentation pathway for this sugar in Salmonella typhimurium, was purified approximately 600-fold from deoxyribose grown cells. The purified enzyme was shown to be nearly homogeneous by the criteria of sedimentation equilibrium centrifugation, sucrose density gradient centrifugation, and polyacrylamide disc gel electrophoresis in the presence and absence of sodium dodecyl sulfate. A rapid radiochemical assay for deoxyribokinase was developed, which permits the direct measurement of phosphorylated product in the absence of coupling systems. (TSS) (Diss. Abstr. Int., B)

48460 FRACTIONATION CORRECTIONS FOR MIXED-ISOTOPE SPIKES OF Sr, K, AND Pb. Hofmann, Albrecht (Univ., Heidelberg). Earth Planet. Sci. Lett.; 10: 397-402(Mar 1971).

Methods are given to correct for isotopic fractionation in the determination of the isotopic composition of mixed-isotope spikes. The simplest method, applicable to Sr, utilizes the fact that the fractionated, measured isotope ratios of a critical three-isotope mixture lie exactly on a tie line that connects the true compositions of spike and normal element. Three-isotope elements that do not have critical mixtures require independent determination of the weight ratio of spike to normal element. A new analytic solution together with a straightforward graphical representation is given to the four-isotope problem. (auth)

Activation Procedures

Refer also to abstracts 48726, 48727, 48798, 48802, 50591, 50604, and 50615.

48461 (BNWL-1183-9) MEASUREMENT OF RADIATION EXPOSURE OF ASTRONAUTS BY RADIOCHEMICAL TECHNIQUES. Quarterly Research Report to the NASA Manned Spacecraft Center, April 5, 1971–July 4, 1971. Brodzinski, R. L. (Battelle Pacific Northwest Labs., Richland, Wash.). 15 Jul 1971. Contract AT(45-1)-1830. 16p. Dep. NTIS.

The urine and feces specimens from the Apollo 14 mission were analyzed for their radionuclide content. A cosmic radiation dose estimate of 690 mR is calculated from the observed ^{7}Be concentrations in the inflight fecal specimens. A cosmic radiation dose estimate of 160 mR is calculated from the observed ^{22}Na specific activity in the postflight urine of the Apollo 14 commander. The concentrations of ^{7}Be, ^{22}Na, ^{40}K, ^{51}Cr, ^{59}Fe, ^{60}Co, and ^{137}Cs are given. The ^{59}Fe levels appear to be higher than that which would normally be expected. Aliquots of the urine and feces specimens from the Apollo 14 missions have been neutron irradiated, and the activation products are being analyzed. The concentrations of gold, tin, europium, thorium, hafnium, and tantalum in the fecal specimens from the Apollo 7 through 11 missions are reported. These refined measurements of the tin excretion rates now agree with normal dietary intakes. The excretion of tin does not appear to be flight influenced, while the excretion of the other five elements may be demonstrating a positive response to space flight. A net equilibrium activity of $(2.92 \pm 0.58) \times 10^{-4}$ $d/m/cm^2$ of ^{210}Pb was calculated from a measurement of the ^{210}Po in a piece of the Solar Wind Composition Experiment material exposed to the lunar atmosphere

during the Apollo 12 landing. This is equivalent to an equilibrium lunar surface activity of $(5.01 \pm 0.99) \times 10^{-2}$ d cm^{-2} sec^{-1}. (auth)

48462 (CONF-710325–1) UTILIZATION OF ACTIVATION ANALYSIS AS A DETECTION TECHNIQUE FOR MERCURY. de Goeij, J. J. M. (Interuniversitair Reactor Instituut, Delft (Netherlands)). [1971]. 10p. Dep. NTIS (U. S. Sales Only).

From Meeting on environmental pollution; Mol, Belgium (18 Mar 1971).

A simple, rapid and sensitive analysis for mercury, based on neutron activation analysis and automated chemical separations is described. Mercury levels for Dutch birds, river water, river sediments, grass and cows (meat, kidney, liver, brain and milk) are presented. (auth)

48463 (CONF-710402–(Vol.2), pp II.61-6) ^{252}Cf FOCUSED NEUTRON GUN FOR ACTIVATION ON SKIN-TISSUE TO DETECT ABOVE-NORMAL AMOUNTS OF SODIUM. Alvi, Zahoor M. (Kaiser-Permanente Medical Center, Los Angeles, Calif.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

A portable californium-252 neutron gun was designed to activate sodium atoms contained in the skin and subcutaneous tissue. Two sealed sources 10 microgram (0.54 × 10 mCi) each are positioned inside the probe assembly. Two cadmium lined collimators converge the neutron beams from the two point sources. The entrance field is just 1 cm × 1 cm at the skin surface. The exposure time is of the order of 15 min. The thermal neutrons and fast neutrons with a maximum at 1 MeV, activate the sodium atoms and also other elements contained in a tissue volume about 2 ml located a few mm below the outer skin surface. The estimated induced activity is of the order of 2000 dpM. The ^{24}Na atoms that are formed decay with the emission of 1.37 MeV gamma photons. This activity is picked up by a solid-state lithium-drifted silicon detector mounted above the probe at the end of the central channel that provides a direct pathway from the activated tissue. The Li(Si) detector provides good scatter discrimination. The detector output goes through a pulse-height analyzer and is related to the concentration of the sodium content below the skin near the sweat glands. Likewise potassium concentration can be determined. The Na/K ratio can be used as a detection index for cystic fibrosis. The ratio is 2½ times higher for children with cystic fibrosis compared with children considered normal. The probe is intended to be compact and portable enhancing the application of neutron activation analysis in clinical medicine and research. The probe obviates the necessity of collecting any biological samples. (auth)

48464 (CONF-710402–(Vol.2), pp II.67-70) PRACTICAL APPLICATIONS AND LIMITATIONS OF FORENSIC ACTIVATION ANALYSIS. Hoffman, C. Michael; Pro, Maynard J. (Department of the Treasury, Washington, D. C. National Office Lab.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

Forensic activation analysis (FAA) is an accepted and valuable tool for examining many types of physical evidence and it is currently used on a routine basis to supplement and extend other types of analyses. Soil, hair, paint, and gunshot residue are some of the materials commonly encountered in the crime laboratory to which FAA may be appropriately applied. FAA can rarely be used alone, however, since other information about the crime scene samples and specimens from the suspect must be obtained by using multiple methods of analysis. Other factors such as analytical time and cost limit the use of FAA in the crime laboratory. (auth)

48465 (CONF-710402–(Vol.2), pp II.71-6) ROLE OF ENVIRONMENTAL CONTAMINATION IN CRIMINALISTICS: A CASE HISTORY. Pillay, K. K. S.; Thomas, C. C. Jr.; Mahoney, G. F. (Western New York Nuclear Research Center, Inc., Buffalo).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

The case history of a unique application of neutron activation analysis to criminalistics is presented. Neutron activation analysis of trace levels of tungsten, cobalt, and tantalum present in a variety of evidence materials were employed to establish the probable presence of the suspect at the scene of a murder. The evidence materials included the blouse of the victim, bed sheets, a pair of pantyhose used in strangulation, and head and pubic hair of the suspect. Stained areas of the fabrics were found to contain the elements tungsten, cobalt, and tantalum, which are not normally found in fabrics or in household environment. The occupation of the suspect exposed him to fine dust particles containing these elements. In addition, eyewitness accounts indicated that the suspect was in the neighborhood where the murder took place near the time of the murder. There was, however, no evidence other than the neutron activation analysis results to indicate that he may have been at the scene of the crime. The court accepted the neutron activation analysis results and the jury trial resulted in a conviction. (auth)

48466 (CONF-710402–(Vol.2), pp II.77-80) STATE-WIDE TRAINING AND SERVICE PROGRAM IN FORENSIC NEUTRON ACTIVATION ANALYSIS. Vogt, James R.; Eichor, Matthew E.; Mason, Ronald E. (Missouri Univ., Columbia).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

During the past year the University of Missouri has begun a state-wide program in forensic neutron activation analysis. This effort is intended to provide a sophisticated program in the characterization of physical evidence through the prudent application of neutron activation combined with the training of investigative officers in proper sample collection and handling procedures as well as in the capabilities and limitations of this analytical technique. A training program for police laboratory personnel is included to enhance their overall scientific background in practical applications of modern analytical chemistry. This part of the program is not limited to activation analysis. The training portion of the program is organized by the University's Law Enforcement Extension Education staff who regularly conduct training programs throughout the State of Missouri. The overall program emphasizes close cooperation between investigating officers and the scientific staff in order to provide a coordinated approach. (auth)

48467 (CONF-710402–(Vol.2), pp II.81-6) STATISTICAL INTERPRETATION OF TRACE ELEMENT PATTERNS IN PAPER. Lukens, H. Richard; Schlesinger, Howard L. (Gulf Radiation Technology, San Diego, Calif.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

The qualitative and quantitative trace element patterns, as determined by neutron activation analysis (NAA), in a suite of 40 different bond papers was subjected to statistical analysis. The eight most frequently observed elements, Ti, Al, Ca, Na, Mn, Cl, Cr, and Sb were selected for this purpose. With few exceptions the distribution functions of these elements could be described by neither Gaussian nor linear forms. However, the observed densities were found to be satisfactorily self-defining. That is, the frequence with which given combinations of concentrations of each pair of elements occurred (the Na–Cl pair was the sole exception) could be accurately predicted by multiplication of their individual densities. Thus, in addition to the fact that different trace element patterns indicate different papers, it is now possible to compute the probability that a given trace element pattern of one bond paper will be matched by that of a different name brand of paper. The average, greatest, and least probabilities of such an accidental match, based on 7 elements, are on the order of 10^{-5}, 10^{-3}, and 10^{-10}, respectively. (auth)

48468 (CONF-710402–(Vol.3), pp III.7-19) UNDERSEA MINERAL ANALYSIS WITH ^{252}Cf. Noakes, John E.; Smithwick, Grover A. (Georgia Univ., Athens); Kirst, Al Jr. (Westinghouse Ocean Research Lab., San Diego, Calif.); Harding, James L. (Oceanonics, Inc., Houston, Tex.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

Present state-of-the-art methods employed in exploration of sea floor mineral deposits deal primarily with shipboard collection of samples and land-based laboratory analyses. Grab sampling and coring methods are the primary means for bottom sampling. Unfortunately these methods can result in the collection of distorted, unrepresentative samples of the sea floor. An undersea neutron activation analysis system has been developed which permits immediate elemental analysis from undisturbed sea floor mineral deposits. Californium-252 has been utilized as a neutron source for the activation analysis system. Elemental analyses of minerals in ore grade concentrations have been successfully demonstrated. Delivery of the activation analysis system to the sea floor has been accomplished by three different modes of operation: an undersea submersible for deep water capabilities; a sled for intermediate depths; and scuba divers for shallow water operations. Minimum radiation hazards associated with the shipboard handling of ^{252}Cf have been demonstrated. (auth)

48469 (CONF-710402–(Vol.3), pp III.20-9) ^{252}Cf NEUTRON ACTIVATION FOR TERRESTRIAL, SEA FLOOR, AND POSSIBLE PLANETARY SURFACE ANALYSIS. Perkins, R. W., Haller, W. A.; Rieck, H. G.; Rancitelli, L. A.; Wogman, N. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

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From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

The high neutron emission rates presently available from ^{252}Cf sources have dramatically improved the potential applications of both laboratory and in situ neutron activation analyses of minerals. In recent laboratory studies of 200 lb ore samples, techniques have been developed which permit the very rapid analysis of more than 16 elements at concentrations that are generally well below those of commercial interest. These developments were based on studies conducted with 260 μg and 1.8 mg ^{252}Cf sources for neutron activation and a 50 cc Ge(Li) diode for the γ spectrometric analysis. In feasibility studies carried out in several feet of water in an ocean tidal zone, it was demonstrated that elements such as Au, Ag, and Mn could be measured in concentrations as low as a few ounces per ton. The technology, which has been developed for either ground-based or shipboard laboratory mineral analysis, the technology and equipment that is being developed for in situ analysis of the floors of fresh- and saltwater basins, and the potential applications of this technology for planetary surface analysis are described. (auth)

48470 (CONF-710402–(Vol.3), pp IV.1-10) RADIOISOTOPE NEUTRON ACTIVATION FOR ON-STREAM PROCESS ANALYSIS. Rhodes, John R. (Columbia Scientific Industries, Austin, Tex.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

The high penetration of neutrons and gamma rays makes nuclear techniques well-suited to on-stream analysis in industrial conditions. The availability of neutron-emitting radioisotope sources, particularly ^{252}Cf, makes possible the manufacture of relatively inexpensive, rugged, and reliable process analyzers. Progress in development of techniques and instrumentation is reviewed. Early work was limited to laboratory demonstrations of the activation of fluorine, vanadium, manganese, selenium, silver, and indium in flowing solutions. More recently, parts-per-million sensitivity has been reported for on-stream determination of sodium, magnesium, aluminum, chlorine, cobalt, copper, and hafnium in solutions using a nonrecirculating loop system designed for industrial process analysis. The practicability of recirculating systems for slurry analysis has also been demonstrated and the development of instruments for on-stream monitoring of fluorine, barium, and silicon in ores reported. Current work is reported herein on the use of ^{252}Cf for on-stream determination of low cobalt levels in process solutions; copper, silver, and gold in ores; and calcium in cement raw mix. (auth)

48471 (CONF-710402–(Vol.3), pp IV.11-17) USE OF A SEALED TUBE NEUTRON GENERATOR FOR QUALITY CONTROL IN EXPLOSIVES BY FAST NEUTRON ACTIVATION ANALYSIS (FNAA). Semel, Stanley; Helf, Samuel (Picatinny Arsenal, Dover, N. J. Feltman Research Labs.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

Two years of experience with a Kaman Nuclear sealed tube neutron generator for FNAA is reviewed. The history of the neutron output for the first sealed tube used with this system for 70 hours of operation is described and the operational experience is briefly discussed. The analysis for total nitrogen content via the $^{14}N(n,2n)^{13}N$ reaction for a variety of organic explosives is described. Data are given for nitrocellulose, TNT, HMX, and Octols. High accuracy and precision, comparable to wet chemical analysis was obtained using dual-axis rotation during irradiation and careful choice of reference standard. Comparison of accuracy and precision was also made with a single-axis rotation method. Application of FNAA to the analysis of binary mixtures containing two compounds of different nitrogen content is also described. The total nitrogen content of a sample is first measured by activation and then related to composition of the mixture. This method is applied to Octol compositions, containing varying proportions of TNT (18.50% N) and HMX (37.84% N). A method technique is described for the simultaneous irradiation of nine Octol samples and one reference standard using single-axis rotation. The precision of duplicate assays for 378 plant samples is given and discussed. (auth)

48472 (CONF-710402–(Vol.3), pp IV.18-29) APPLICATION OF NEUTRON CAPTURE GAMMA RAYS USING A ^{252}Cf NEUTRON SOURCE TO INDUSTRIAL PROCESS STREAM ANALYSIS. Duffey, Dick (Maryland Univ., College Park); Wiggins, Peter F. (United States Naval Academy, Annapolis, Md.); Senftle, Frank E. (Geological Survey, Washington, D. C.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

An examination of the neutron capture gamma method using a ^{252}Cf neutron source indicated that this technique may be feasible for process stream analysis and control of certain elements. Simulated laboratory experiments were made on iron in taconite and magnetite, and copper and nickel in their respective ores. Satisfactory analyses were obtained for 500 to 1000 g samples in a combined irradiation and counting time of 100 minutes. For large industrial size samples this time could be shortened. Based on these experiments, a set of guidelines are given for the use of the neutron capture gamma method in an industrial plant. (auth)

48473 (CONF-710402–(Vol.3), pp IV.30-9) FAST PROCESS MEASUREMENT FOR MANGANESE IN STEELS BY NEUTRON ACTIVATION ANALYSIS. Aron, Steven J. Jr. (Republic Steel Corp., Cleveland, Ohio. Nucleonics Div.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

A 1120.9-microgram source of californium-252, emitting 2.6×10^9 neutrons per second, was used for neutron activation analysis of manganese in steels. With the aid of specially made steels limiting curves were developed to define the limit of matrix effect errors inherent in the analysis. By means of these limiting curves it is possible to determine the concentration of manganese in either high or low alloy steels with an accuracy of ±3% of the actual content. Low alloy bar stock and basic oxygen furnace samples were analyzed using standards as time bases. This method greatly simplifies the manganese measurement. In the case of the basic oxygen furnace steels obtained from molds, the neutron activation method is demonstrated to be a fast and accurate process measurement tool. The accuracy of the method is comparable to present analytical techniques and is accomplished in approximately 2 minutes. (auth)

48474 (CONF-710402–(Vol.3), pp IV.40-6) PROMPT GAMMA-RAY COAL ANALYSIS SYSTEM. Parsignault, Daniel R.; Wilson, Henry H.; Mineski, R. (American Science and Engineering, Inc., Cambridge, Mass.); Blatt, S. L. (Ohio State Univ., Columbus. Dept. of Physics).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

A system designed to measure the prompt γ rays produced by the interaction of thermalized neutrons from a californium-252 source with the constituents of coal is described. The system operates at a total counting rate of 1 Megahertz, with an energy resolution of ~5% at 5 MeV. Such high counting rates allow for the determination of the sulfur content of coal with an error of less than 2%, in a few minutes. To obtain this accuracy in this short time period, a NaI(Tl) detector surrounded by a plastic anti-Compton shield together with a sophisticated electronic system rejecting pile-up events is used. The γ spectra are collected in a mini-computer which analyzes them, while monitoring and adjusting the system continuously. (auth)

48475 USE OF BORON AND INDIUM FILTERS IN THE ACTIVATION ANALYSIS BY REACTOR NEUTRONS. Damburg, N. A.; Pelekis, L. L. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 2, 3-9(1971). (In Russian).

Cadmium–boron ratios for 53 isotopes for the filter 0.5 mm Cd + 2.0 mm B_4C and cadmium–indium ratios for 20 isotopes for the filter 0.5 mm Cd + 0.1 mm In have been measured. As an example of the filters used, the method of determination of molybdenum in ore is described. (auth)

48476 ACTIVATION METHOD FOR THE DETERMINATION OF DEUTERIUM USING LINEAR ACCELERATOR. Starchik, L. P.; Abbosov, O.; Abrams, I. A. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 2, 10-12(1971). (In Russian).

The method for determining deuterium using the (γ,n) reaction is described. As a source of γ rays the linear electron accelerator with 5-MeV electrons and 0.5-ma beam is used. The neutrons emitted due to the (γ,n) reaction and characterizing the D_2O content in the sample are measured by means of the dysprosium detector. The limit sensitivity of deuterium determination for 200-ml samples at measuring time about 3 to 4 minutes is 2.1×10^{-4}%. (auth)

48477 DETERMINATION OF TRACES OF MERCURY IN TOMATOES AND INDUSTRALIZED PRODUCTS FROM TOMATOES. Silva, Celia M.; Lima, Fausto W. (Instituto de Energia Atomica, Sao Paulo, Brazil). Rev. Brasil. Technol.; 1: No. 2, 67-79(Dec 1970). (In Portuguese).

A study was made of the various factors that may interfere with the determination of mercury, by activation analysis, in tomatoes

and commercial products obtained from tomatoes. The method can also be applied for the analysis of that element in pesticides as well as in parts of the tomato tree. Chemical separation of mercury ions is carried out by isotopic exchange with metallic mercury. Sensitivity of the method is of the order of 0.01 μg and concentration of the order of ppB. Precision and accuracy of the method are discussed. (auth)

48478 DETECTION OF THALLIUM POISONINGS BY MEANS OF NEUTRON ACTIVATION ANALYSIS. Henke, G.; Fitzek, A. (Westfaelische Wilhelms-Univ., Muenster, Ger.). Arch. Toxikol.; 27: No. 3-4, 266-72(1971). (In German).

A method for detecting thallium poisonings and their date of occurrence using single hair and toenail sections and applying neutron activation analysis is reported. After high-level neutron irradiation of the samples, separation and measurement of thallium is performed by amalgam exchange and the liquid scintillation counting of ^{204}Tl. Using a neutron dose at 2.59×10^{19} n/cm^2, it was possible to detect a repeated thallium poisoning in one hair. The detection limit of the method was determined to be 10^{-4} μg or 2 to 3 ppM Tl. (auth)

48479 SEARCH FOR INTERNAL ISOTOPIC TRACERS IN METALLURGICAL MATERIALS. I. DETERMINATION OF In, W, As, Au, Sc, Re, Ir, AND La BY THE NEUTRON ACTIVATION METHOD. Jaskolska, H.; Rowinska, L.; Radwan, M. (Inst. of Nuclear Research, Warsaw). J. Radioanal. Chem.; 7: No. 1, 29-39(Jan 1971).

In a search for internal isotopic tracers in metallurgical materials a group of elements has been chosen which can be determined by the neutron activation method with the highest sensitivity. A method was developed for the determination of W, As, Au, La, In, Sc, Re, and Ir in metallurgical materials. The separation of the elements was carried out using extraction and precipitation. The determination of the elements was carried out in samples of chamotte brick and washed ores. The limits of the determination of the elements are of the order of 10^{-11} g for Au, 10^{-10} g for In and La, and 10^{-9} g for As, W, Sc, Re, and Ir. The large scatter of the results indicates the inhomogeneity of the materials analyzed. (auth)

48480 NON-DESTRUCTIVE DETERMINATION OF URANIUM AND THORIUM IN GEOLOGICAL MATERIALS BY RESONANCE-NEUTRON ACTIVATION ANALYSIS. Meyer, H. G. (Technische Hochschule, Munich). J. Radioanal. Chem.; 7: No. 1, 67-79(Jan 1971).

A simple method is described for the determination of uranium and thorium in geological materials. The samples are irradiated in a reactor with resonance and fast neutrons behind a cadmium filter. Compared with an irradiation with the whole reactor neutron spectrum, the matrix activities are reduced to about 1%, those of uranium (^{239}Np) and thorium (^{233}Pa) to about only 50 and 25%, respectively. This relative diminution of matrix activities allows the γ-measurement of ^{239}Np and ^{233}Pa as early as after two days' cooling time; in samples with high uranium contents the determination of ^{233}Pa requires one month's cooling time. This non-destructive procedure yields a detection limit of 0.1 ppM for uranium and thorium in samples of 200 mg, with an error of ±5%. (auth)

48481 FAST NEUTRON ACTIVATION: SAMPLE PREPARATION UTILIZING GRAPHITE AS A DILUENT. Stalnaker, N. (Univ. of New Mexico, Albuquerque); Kahn, M.; Kenna, B. J. Radioanal. Chem.; 7: No. 1, 81-7(Jan 1971).

A method was developed for the preparation of irradiation samples that ensures that both standard and unknown samples are of the same size, shape, density, and composition. Powdered standard and unknown samples were diluted with graphite to give homogeneous mixtures containing ≥80% graphite; these mixtures were pressed into cylindrical pellets. This method of sample preparation was applied to the determination of nitrogen in organic and polymeric compounds. The results generally agree with Kjeidahl analyses within 5%. (auth)

48482 CONTRIBUTION TO THE STUDY OF THE DETERMINATION OF Be, B, C, N, O, AND F BY MEANS OF ACTIVATION BY p, d, ^{3}He, AND α. I. ACTIVATION CURVES AND SENSITIVITY OF DETECTION. Engelmann, Ch. (CEN de Saclay, Gif-sur-Yvette, France). J. Radioanal. Chem.; 7: No. 1, 89-101(Jan 1971). (In French).

The activation of these elements, homogeneously contained in a medium thicker than the path length, of slowing-down capacity close to that of aluminum, was determined as a function of energy by irradiating standards with p, d, ^{3}He, and α particles of energies between: 5 and 15 MeV for protons, 5 and 20 MeV for deuterons and ^{3}He particles, 25 and 42 MeV for α particles. The detection sensitivities intrinsically possible in these energy ranges are deduced from the curves obtained. The results apply to all materials through a simple relation taking into account the path lengths. They may be used in particular to foresee the possibilities offered by activation with these charged particles, from the viewpoint of sensitivity, when the samples to be analyzed are irradiated with a beam of given intensity and energy lying between the above limits. (auth)

48483 DETERMINATION OF SILICON IN ALUMINUM BY 14 MeV NEUTRON ACTIVATION ANALYSIS. Buczko, M.; Csikai, J.; Varga, G. (Kossuth Univ., Debrecen, Hungary). J. Radioanal. Chem.; 7: No. 1, 103-6(Jan 1971).

A method was developed for determining silicon in aluminum by fast neutron activation. It is based on the separation of two gamma lines by a Ge(Li) detector: the 1.73-MeV line from the product of ^{27}Al(n,α)^{24}Na and the 1.78-MeV line from the ^{28}Si(n,p)^{28}Al reaction. In the case of aluminum–silicon alloys 100 μg silicon can be determined with an error of 10% in an aluminum sample of 1 g. (auth)

48484 DETERMINATION OF THE TRACE ELEMENT LEVELS IN ATMOSPHERIC POLLUTANTS BY NEUTRON ACTIVATION ANALYSIS. Pillay, K. K. S.; Thomas, C. C. Jr. (Western New York Nuclear Research Center, Inc., Buffalo). J. Radioanal. Chem.; 7: No. 1, 107-18(Jan 1971).

An investigation of the potentials of neutron activation analysis for the routine analysis of trace elements present in atmospheric pollutants is discussed. Various techniques including sequential air sampling, multiple neutron irradiation, high resolution γ-ray spectrometry, chemical isolation, high flux neutron irradiation, and x-ray spectrometry were employed to determine the levels of Pb, Al, V, I, Cl, Mn, Cu, Br, Na, La, Mo, Au, Cr, Fe, Ni, Se, Zn, Ag, and Co in atmospheric pollutants. The results of the analysis of nearly two hundred samples collected from the Buffalo, New York, area during 1968 and 1969 are reported. (auth)

48485 DUAL PNEUMATIC TUBE TRANSFER SYSTEM FOR THE ANALYSIS OF FAST NEUTRON ACTIVATED SHORT-LIVED ISOTOPES. Adamek, A.; Severa, F. (Inst. of Physics, Bratislava). J. Radioanal. Chem.; 7: No. 1, 119-25(Jan 1971).

A description is given of an automatically controlled fast pneumatic transfer system using a rotating dual-sample irradiation assembly. The system was developed for use in activation analysis. (auth)

48486 USE OF THE NG-160 NEUTRON GENERATOR FOR THE NEUTRON-ACTIVATION ANALYSIS OF SANDYCLAYEY ROCKS TO DETERMINE THE CONTENTS OF SILICON AND ALUMINUM. Dubinchuk, V. T.; Kasatkin, V. A.; Mikhailov, N. A.; Chulanov, Yu. G. Izotopy SSSR; No. 19, 19-24(1970). (In Russian).

A method is described for the very rapid neutron activation analysis for silicon and aluminum in sedimentary rock. Different samples of sand-clay rocks were used to test the method. A formula is given for error estimation for a single determination as a function of the activation conditions and the measurement of the induced activity. (tr-INIS)

48487 ACTIVATION ANALYSIS OF STRONTIUM BY γ–γ′ REACTION. Kodiri, S.; Starchik, L. P. Izotopy SSSR; No. 19, 6-8(1970). (In Russian).

A method of activation analysis for strontium is described based upon the resonance excitation reaction (γ,γ′). The proposed method permits highly selective analyses, and one adaptation of it will make possible the analysis for strontium in the presence of barium. (tr-INIS)

48488 INVESTIGATION OF CUPELLING METHOD USED FOR RUTHENIUM AND IRIDIUM ISOLATION. Daiev, Ch.; Georgiev, G.; Jovtschev, M.; Stefanov, G.; Apostolov, D. (Univ., Sofia). Isotopenpraxis; 7: No. 4, 138-41(Apr 1971). (In German).

Ruthenium-103 and ^{192}Ir were used to explore the single steps of the cupellation method (cupellation, lead vaporization, etc.) used for the isolation of the two platinum metals. Optimum conditions (temperature, composition of slag-forming constituents) were determined with ruthenium or iridium losses ranging from 2.7 to 2.9%. Investigations showed that lead cupellation down to silver grain causes losses, which are unacceptable with regard to analyzing purposes. Therefore, incomplete lead cupellation down to lead grain ranging from 0.2 to 0.7 g is proposed. The residual lead grain may be subjected to neutron activation analysis. This technique renders possible the determination of platinum metals in ores, rock, and minerals. (auth)

48489 DETERMINATION OF OXYGEN IN ALUMINUM ELECTROLYTIC BATHS BY A FAST-NEUTRON ACTIVATION METHOD. Takada, K.; Fujii, I.; Ishihara, M.; Muto, H. (To-

XUM

shiba Research and Development Center, Kangawa, Japan). Anal. Chim. Acta; 55: No. 1, 19-27(Jun 1971).

Oxygen in various materials can be determined by rapid, nondestructive fast-neutron activation analysis with a small neutron generator. The applicability of the method for determination of alumina in aluminum electrolytic baths, which is a very important factor in efficient aluminum metal production, has been studied. One of the major problems associated with this method is the interference of fluorine from cryolite. This difficulty has been eliminated by using a functional relation of the $^{16}N/^{18}F$ activity ratio and the oxygen/fluorine ratio in the sample. The alumina content in baths can be determined with a precision of 10 to 15% to 15 to 20% for 10 to 5% alumina concentrations. (auth)

48490 DETERMINATION OF ANTIMONY IN STANDARD ROCKS BY INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS. Lombard, S. M. ((Naval Research Lab., Washington, D. C.); Marlow, K. W.; Tanner, James T. Anal. Chim. Acta; 55: No. 1, 13-17(Jun 1971).

The abundance of antimony in the standard rocks G-1, W-1, G-2, BCR-1, AGV-1, PCC-1, DTS-1, GSP-1, SUL-1, SYE-1, BCR-2, and GR was determined by instrumental neutron activation analysis. Comparison of the results of this work with those previously reported indicate that DTS-1 is the best choice as an antimony standard. Results for SYE-1, G-1 and AGV-1 indicate that these standards may not be sufficiently homogeneous. (auth)

48491 NEUTRON ACTIVATION METHOD FOR THE DETERMINATION OF THORIUM IN ROCKS AND MINERALS USING THE 22-MINUTE ^{239}Th ACTIVITY. Norton, Elinor F.; Stoenner, R. W. (Brookhaven National Lab., Upton, N. Y.). Anal. Chim. Acta; 55: No. 1, 1-11(Jun 1971).

A method is described for the determination of thorium in rocks and minerals which utilizes neutron activation, a radiochemical separation scheme, and counting of the thorium-233 β-activity. A discussion is presented of various dissolution procedures used for silicate rocks with the conclusion that a potassium fluoride–pyrosulfate fusion is preferable to acid dissolution or sodium peroxide fusion or sinter. The sensitivity of the method is 10 ppB with a 100-mg sample. Results are given for the USGS standard rocks. (auth)

48492 DETERMINATION OF TRACE ELEMENTS IN BIOLOGICAL MATERIALS BY NEUTRON ACTIVATION ANALYSIS. van den Winkel, P. (Paleis der Acadamien, Brussels). Verh. Kon. Vlaam. Acad. Wetensch., Belg., Kl. Wetensch.; 32: No. 114, 189p(1970). (In Flemish).

Several separation schemes for the determination of major and trace constituents in blood, brain tissue, and kale powder (a biological standard) by neutron activation analysis are presented. Possible sources of errors are discussed. The efficiencies of solid and well-type NaI(Tl) and Ge(Li) detectors are obtained from the absolute disintegration values of ^{141}Ce, ^{51}Cr, ^{198}Au, ^{137}Cs, ^{54}Mn, ^{65}Zn, ^{59}Fe, and ^{42}K. The use of the Fermi–Curie plot for the identification of pure β-emitters is demonstrated. (253 references) (Anal. Abstr.)

48493 PERCHLORODIPHENYLMETHYL STABLE FREE RADICAL. X-RAY ANALYSIS OF A DISORDERED MIXED CRYSTAL. Silverman, J.; Soltzberg, L. J.; Yannoni, N. F.; Krukonis, A. P. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Phys. Chem.; 75: 1246-50(29 Apr 1971).

A single crystal originally believed to be pure perchlorodiphenylmethyl free radical, $(C_6Cl_5)_2\dot{C}Cl$, is monoclinic, space group $P2_1/c$, with a = 9.71, b = 13.29, c = 14.67 Å, β = 97.1°. The x ray structure determination was supplemented by analytical techniques of elemental microanalysis, ESR spectroscopy, mass spectrometry, and neutron activation analysis in order to characterize a crystalline disorder present in the specimen. While about 37% of the molecules in the crystal are the expected free radical, the crystal also contains about 36% of a related molecule with bromine, probably $(C_6Cl_5)_2CBrCl$, and also a third species, possibly $(C_6Cl_5)_2CHCl$. Although the elements of disorder in the structure limit the accuracy of the determination, the main features of the free radical structure as well as the deformations in the similarly overcrowded molecules are revealed. The "composite molecule" obtained in the x ray analysis has approximately twofold symmetry with the phenyl rings rotated by 47 and 43° with respect to the trigonal plane of the central carbon atom. The five chlorine atoms of each phenyl ring deviate from planarity in zigzag fashion. (auth)

48494 RADIOACTIVATION METHOD FOR DETERMINING OXYGEN IN SOLID SUBSTANCES BY THE PHOTONUCLEAR REACTION WITH A SENSITIVITY OF 10^{-6} TO 10^{-5} WT. PERCENT. Chapyzhnikov, B. A.; Vasserman, A. M.; Kunin, L. L.; (and others) (Inst. of Geochemistry and Analytical Chemistry, Moscow. Inst. of Physical Problems, Moscow). Zh. Anal. Khim.; 26: No. 7, 1366-72(Jul 1971). (In Russian).

A method was developed for the γ-activation determination of oxygen in pure metals with the use of a microtron as a source of gamma quanta. The sensitivity of the method is 7×10^{-6} wt % of oxygen for 1-g samples and an average microtron current of 5 μA. The variation coefficient is about 10%. (auth)

48495 METHOD FOR THE NON-DESTRUCTIVE ASSAY OF BULK NUCLEAR REACTOR FUEL AND APPARATUS. (to National Nuclear Corp.). British Patent 1,240,235. 21 Jul 1971. Priority date 13 May 1968, United States.

A nondestructive neutron irradiation method for the assay of reactor fuels employs neutrons of an energy such that both the prompt neutrons due to fission of the fissionable materials and the delayed neutrons from their fissions can be counted. From the relationships of the prompt and delayed neutron counts by reference to appropriate samples for calibration, the amount of fissionable material present and the difference between ^{235}U and ^{239}Pu can be determined. (B.L.M.)

48496 NEW METHOD FOR THE RAPID NON-DESTRUCTIVE DETERMINATION OF BORON, OXYGEN, AND FLUORINE, BY γ ACTIVATION AND COUNTING OF DELAYED NEUTRONS EMITTED BY ^{9}Li AND ^{17}N. (Engelmann, Ch.; Scherle, A. C. (Departement de Physico Chimie, Saclay, France). Int. J. Appl. Radiat. Isotop.; 22: No. 7, 415-23(Jul 1971). (In French).

Boron, oxygen, and fluorine can be determined by means of the photonuclear reactions; $^{11}B(\gamma,2p)^{9}Li$, $^{18}O(\gamma,p)^{17}N$ and $^{19}F(\gamma,2p)^{17}N$. ^{9}Li and ^{17}N are delayed neutron emitters of half-lives 0.176 and 4.2 s respectively. The setup used for these special analyses is described. The detection sensitivities intrinsically possible are given for maximum energies of 40 to 62 MeV and an incident electron beam intensity of 50 μA average. The relative magnitude of the main interferences is discussed. (auth) (UK)

Inorganic, Organic, and Physical Chemistry

Refer also to abstract 49592.

Chemical Properties

Refer also to abstracts 49098 and 49521.

48497 (SC-R-71-3315(Vol.1)) FUSED SALTS: A BIBLIOGRAPHY. VOLUME I. ACCESSION LIST. Schalit, Michael (Sandia Labs., Livermore, Calif.). Jul 1971. 518p. Dep. NTIS.

This publication incorporates the bibliographic data published in SC-R-68-1680–"Fused Salt Mixtures: Eutectic Compositions and Melting Points" and SC-R-69-1386–"Fused Salt Mixtures: Specific Conductivity Tables" with added references compiled from the Chemical Abstracts through July 1971. (auth)

48498 (SC-R-71-3315(Vol.2)) FUSED SALTS: A BIBLIOGRAPHY. VOLUME II. SUBJECT/PERMUTED TITLE LIST. Schalit, Michael (Sandia Labs., Livermore, Calif.). Jul 1971. 654p. Dep. NTIS.

48499 (SC-R-71-3315(Vol.3)) FUSED SALTS: A BIBLIOGRAPHY. VOLUME III. AUTHORS LIST. Schalit, Michael (Sandia Labs., Livermore, Calif.). Jul 1971. 274p. Dep. NTIS.

48500 PHASE RELATIONS IN FLUOROBORATE SYSTEMS. II. THE SYSTEM NaF–KF–BF_3. Barton, Charles J.; Gilpatrick, L. O.; Bornmann, John A.; McVay, T. N.; Insley, Herbert (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem.; 33: No. 2, 345-50(Feb 1971).

Two quasi-binary systems were identified in the system formed by the compounds NaF, $NaBF_4$, KBF_4, and KF. The only part of the NaF–KF–BF_3 system that can be studied at atmospheric pressure contains a maximum of 50 mole % BF_3. Differential thermal analysis and quenching data indicate that the high-temperature polymorphs of $NaBF_4$ and KBF_4 form a continuous series of solid solutions with a very shallow minimum, melting at 398°C, near the 90 mole % $NaBF_4$ composition. There is some evidence for the existence of a sub-solidus compound, $3NaBF_4 \cdot KBF_4$, which is stable between approximately 193° and 280°C. The compounds NaF and KBF_4 form a simple eutectic system containing 94 ± 1 mole % KBF_4 which melts at 539 ± 2°C. The ternary system is dominated by a large NaF primary phase field. There is a shallow ternary minimum, corresponding to the $NaBF_4$–KBF_4 quasi-binary minimum, containing 3.5 ± 1 mole % KF and 48 ± 1 mole % BF_3 which has a liquidus temperature of 377 ± 2°C. The ternary eutectic composition in the NaF–KBF_4–KF triangle is

very close to the $KF-KBF_4$ binary eutectic in composition and it melts at 458°C only about 2° lower in temperature. (auth) (UK)

48501 PHASE RELATIONS IN THE SYSTEM KF–CeF_3. Barton, Charles J.; Gilpatrick, L. O.; Brunton, George D.; Hsu, David; Insley, Herbert (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem.; 33: No. 2, 325-35(Feb 1971).

The system $KF-CeF_3$ was investigated as a function of temperature,and composition by thermal analysis, differential thermal analysis, and gradient quenching. Crystalline phases in the quenched samples were identified principally by use of the polarizing microscope, but selected samples were examined by X-ray powder diffraction. Three compounds were identified: $3KF \cdot CeF_3$, $KF \cdot CeF_3$, and $KF \cdot 2CeF_3$ which melt incongruently at 675 ± 10°C, 755 ± 5°C, and 1135 ± 15°C, respectively. Of these only $KF \cdot CeF_3$ is stable below 585°C. Three peritectic equilibria were observed corresponding to these incongruent melting points at 24, 32, and 63 mole % CeF_3. The $\alpha KF \cdot 2CeF_3$ phase exhibits a substantial solid solubility for KF at temperatures above 795°C which results in a region of cubic solid solution whose properties vary over the composition range from 50 to $66\frac{2}{3}$ mole % CeF_3. (auth) (UK)

48502 PHASE RELATIONS IN FLUOROBORATE SYSTEMS. I. MATERIAL PREPARATION AND THE SYSTEMS NaF–$NaBF_4$ AND KF–KBF_4. Barton, C. J.; Gilpatrick, L. O.; Bornmann, J. A.; (and others) (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem.; 33: No. 2, 337-43(Feb 1971).

High-purity $NaBF_4$ and KBF_4 having higher melting points than any previously reported were prepared. These preparations were used in a reinvestigation of phase relations in the systems $NaF-NaBF_4$ and $KF-KBF_4$ by means of differential thermal analysis (D.T.A.) and gradient quenching techniques. Both were found to be simple eutectic systems with eutectics melting at 384 ± 2°C for the $NaF-NaBF_4$ system. (auth) (UK)

48503 ALKALI URANYL PHOSPHATE PHOSPHORS COACTIVATED WITH RARE EARTHS. Avella, Frank J. (to General Telephone and Electronics Labs. Inc.). U. S. Patent 3,586,634. 22 Jun 1971. Filed 19 Feb 1968.

Condensed alkali uranyl phosphate phosphors coactivated with rare earth ions were prepared in which the alkali metals are chosen from the group Li, Na, K, Rb, and Cs, and the rare earth coactivators are chosen from the group Eu, Sm, and Nd. These phosphors, when excited by ultraviolet, electron, ion, or x-ray radiation exhibit dominant emission colors, which may be varied from green to red through white depending upon the coactivator selected and the molar concentrations. The phosphors may be utilized as color correctors for mercury lamps, in cathode ray tube screens including screens for color television tubes, and in detectors for ion or x-ray beams. (Offic. Gaz.)

48504 OPTIMIZATION BY THE MATHEMATICAL DESIGN METHOD OF THE RADIOCHEMICAL SYNTHESIS OF DIBUTYLTIN DIBROMIDE. Ivanov, A. Yu.; Miretskii, V. Yu.; Nikolaev, N. E. J. Appl. Chem. USSR (Engl. Transl.); 43: No. 12, 2719-22(Dec 1970).

Translated from Zh. Prikl. Khim.; 43: No. 12, 2680-3(Dec 1970).

The optimum conditions for the radiochemical synthesis of dibromodibutyltin (DBTDB) have been found experimentally with initially incomplete knowledge of the process. Since the rate of radiochemical synthesis of DBTDB is raised considerably by the combined use of butyl alcohol and water, interpolation equations have been derived for determining the concentration of the end product as a function of two (temperature and butyl alcohol concentration) or three (temperature, butyl alcohol concentration, and water concentration) variables. The data calculated from these equations can be used for radiochemical reactor design calculations and as a basis for recommendations of industrial adoption of a radiochemical process. (B.L.M.)

48505 PAPER ELECTROPHORETIC INVESTIGATION OF THE FORMATION OF U(IV) HETEROPOLYTUNGSTATES. Botar, A.; Ripan, Raluca (Chemische Institut, Cluj). Rev. Roum. Chim.; 16: No. 6, 807-11(Jun 1971). (In German).

The preparation of U(IV) heteropolytungstates was studied for the first time by paper electrophoresis, and the stability constant, $K = 7.04 \times 10^{-6}$, was determined. It was established that the heteropolyanion $[UW_8O_{28}]^{4-}$ possesses the same stability as other heteropolytungstates for which the stability constants have already been determined. (tr-auth)

48506 OXIDATION AND REDUCTION OF Pu(III), (IV), AND (VI) IN A SOLUTION OF NITRIC ACID AND TBP, DBP. Kaya, Akira; Hiroki, Toshio (Tokai Works, Japan). Nippon Genshiryoku Gakkaishi; 13: No. 7, 366-73(Jul 1971). (In Japanese).

A description is given of observation by extraction and spectrophotometry on the oxidation of Pu(III) by aeration and also on the reduction of Pu(IV) with various concentrations of reducing agents and of nitric acid. Observations were also made on the reduction of Pu(IV) and (VI) extracted in TBP and DBP phases with both nitrous acid and hydrogen peroxides. Further, the adaptability of these reagents to separation and purification of Pu from U and the correct amounts of the reagents required for adjusting the Pu valency were studied. Oxidation of Pu(III) by aeration was quite evident in low acid solution, but insignificant at concentrations above 2.0 M nitric acid. The most suitable concentrations of nitric acid for the reduction of Pu(VI) by nitrous acid (~0.5 M) was below 0.2 M. A percentage reduction in the range of 68–85% was observed for the Pu by nitrous acid in the TBP phase after 5 min, so that the method is quite promising for application to the purification of Pu. A nitric acid concentration of 4.0 M assured 100% conversion to Pu(IV) with an equimolar amount of hydrogen peroxide, while 100% of Pu(III) was obtained on the other hand with hydrogen peroxide added to an amount 10–20 times of the Pu. In the TBP phase the reduction percent of Pu by hydrogen peroxide was only in the range of 35–50% after 20 min, which is significantly inferior to nitrous acid. (auth)

48507 CRYSTALLOGRAPHIC ANALYSIS OF BINDING OF SUBSTRATES AND INHIBITORS TO RIBONUCLEASE S. Allewell, Norma M. New Haven; Yale Univ. (1969). 265p. University Microfilms Order No. 70-15,669.

Thesis.

The crystal structures of several isomorphous derivatives of ribonuclease S in 3 M $(NH_4)_2SO_4$, 0.1 M NH_4Ac, pH 5.5, were determined using the phases of native ribonuclease S and the difference Fourier technique. The structure of N_ϵ-dinitrophenyl-Lys 41-ribonuclease S has been determined to 3 Å resolution. The dinitrophenyl group is bound to the enzyme near the normal position of the sidechain of Arg 39, which it displaces. The conformation of the dinitrophenylated enzyme is slightly different from that of the native enzyme, with shifts of from 0.7 to 1.0 Å occurring over the entire molecule. Shifts remote from Lys 41 may result from nearby dinitrophenyl groups on adjacent molecules. The effect of this conformational change on the binding of Cu^{2+}, $Pt(CN)_4^{=}$, $PtCl_4^{=}$, and UO_2^{2+} was investigated by least squares refinement of 6 Å data. Minor differences in the binding of these ions to the native and dinitrophenylated enzyme were found. The binding of a variety of 3′-nucleotides to the native and dinitrophenylated enzymes was studied at 3 Å resolution. Dinitrophenylation has no apparent effect on their binding, although the binding of nucleotides partially restores the dinitrophenylated enzyme to the native conformation. No difference is observed between the binding of C and U compounds. The binding of Cu^{2+} to the crystalline enzyme was studied at 6 Å resolution. Seven sites were detected at pH 5.5, three of which are intermolecular. Fully guanidinated RNase S was prepared, and shown by difference spectroscopy of bind 3′-CMP almost as well as the native enzyme. Small crystals were obtained, using Na_2HPO_4 as the precipitating agent and their space group was shown to be B2. This derivative appears to have an intrinsic activity of 1% which would prevent its use in the crystallographic study of substrate binding. (Diss. Abstr. Int., B)

48508 URANYL COMPLEXES WITH BIOLOGICAL LIGANDS, PYRIDOXINE, AND ITS URANYL COMPLEXES. PART I. Osman, M. M.; Salem, T. M.; El-Ezaby, M. S. (Alexandria Univ., Egypt). J. Chem. Soc., A; No. 10, 1401-4(1971).

The dissociation constants for pyridoxine hydrochloride were determined both potentiometrically and spectrophotometrically at an ionic strength of 0.50M-KCl at 30°C, and the interaction of the uranyl ion with pyridoxine was studied spectrophotometrically in the pH range 1–12, under the same conditions. It was shown that three mononuclear complexes were formed in the pH range 1–7.5, the pK values for the three stepwise instability constants being 11.49, 8.48, and 3.76. Data in the pH range 7.5–12 could not be interpreted adequately. (auth) (UK)

48509 COMBINED ION EXCHANGE-SOLVENT EXTRACTION PROCESS (ELUEX) FOR AMMONIUM DIURANATE PRODUCTION. Fisher, J. W.; Vivyurka, A. J. (Rio Algom Mines Ltd., Elliot Lake, Ont.). pp 163-73 of Ion Exchange in the Process Industries. London; Society of Chemical Industry (1970).

From International conference on ion exchange in the process industries; London, England (16 Jul 1969). See CONF-690712.

The production of ammonium diuranate from Blind River ores by a combined ion exchange–solvent extraction process was investigated in the laboratory, using a semi-continuous mini-plant apparatus, under simulated plant conditions, for almost a year. During this study the effect of a combined ion exchange–solvent extraction and precipitation process, within a closed system, was

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monitored and found to be stable. A fixed-bed strongly basic anion exchange resin and a tertiary amine (0.1 m) in kerosene diluent formed the basis of the system. Ion exchange operation (which already forms an integral part of existing production facilities) does not deteriorate under the effects of entrained solvent in recycled acid. Loading capacities of 4 lb U_3O_8/ft^3 were maintained, and overall ion exchange efficiency was in the range 99.7 to 99.9%. Trace impurity levels within the system became stable after several cycles of operation, with the exception of nitrate ions (present in the acid liquor feed to the process), which eventually began to retard solvent loading. Solvent losses were difficult to measure, but indications were that they were low. Using gaseous ammonia for solvent stripping and careful pH control, the solvent extraction section operated at a maximum efficiency of 92%. Overall ammonia consumption was in the range 0.6 lb NH_3/lb U_3O_8 and this is higher than figures reported in earlier work. Costs were estimated to be 2 to 4 cents per lb U_3O_8 lower than those of the present process, product quality was improved, and the potential disadvantage of nitrate ions in process effluent was removed. A projected flowsheet proposal for integration of the system within existing operations is shown. (auth) (UK)

Isotope Effects and Exchange

Refer also to abstracts 48565 and 50729.

48510 ISOTOPE EFFECT FOR ELECTRON MOBILITY IN ANTHRACENE. Morel, D. L.; Hermann, A. M. (Tulane Univ., New Orleans). Phys. Lett.; 36A: No. 2, 101-2(16 Aug 1971).

Transient photoconductivity measurements on single crystals of deuterated anthracene ($C_{14}D_{10}$) yielded a value of 1.36 ± 0.30 cm^2/volt-sec for the room-temperature electron mobility along the c′ axis. This increase in mobility over $C_{14}H_{10}$ is discussed in the light of recent theoretical predictions. (auth)

48511 METAL-CATALYZED HYDROGEN EXCHANGE BETWEEN PYRIDINE AND DEUTERIUM. Moyes, R. B.; Wells, P. B. (Univ. of Hull, Eng.). J. Catal.; 21: No. 1, 86-92(Apr 1971).

The hydrogen exchange reaction between pyridine and molecular deuterium was investigated using films of Mn (62°C), Co (54 to 84°C), Ni (42 to 95°C), W (62°C), and powdered Ir (−14 to 101°) and Pt (100°C) as catalysts. The activities of these metals fall in the sequence Co ~ Ni ~ Ir ~ Pt > Mn > W, tungsten showing very low activity under the conditions used. All of these metals catalyzed the exchange of the hydrogen atoms at positions 2 and 6 in pyridine (pair exchange). Exchange of hydrogen atoms at all positions (extensive exchange) occurred over freshly prepared Ni at 60°, Ir at 48°, and Pt at 100°C. Activity diminished when catalysts were repeatedly used; for an iridium powder the activity for the exchange of hydrogen atoms at the 3-, 4-, and 5-positions was poisoned more rapidly than the activity for exchange at the 2- and 6-positions. Nickel film at 95°C and platinum powder at 100°C each catalyzed the hydrogenation of pyridine to piperidine. The nickel-catalyzed exchange of 2- and of 3-methylpyridine with deuterium is reported briefly. A mechanism for the exchange reaction is proposed. (auth)

48512 ASPARTATE TRANSCARBAMYLASE: USE OF PRIMARY KINETIC AND SOLVENT DEUTERIUM ISOTOPE EFFECTS TO DELINEATE SOME ASPECTS OF THE MECHANISM. Stark, George R. (Stanford Univ., Calif.). J. Biol. Chem.; 246: No. 9, 3064-8(10 May 1971).

^{14}C- and ^{18}O-labeled carbamyl phosphates were used to study primary kinetic isotope effects in the reaction catalyzed by the catalytic subunit of the aspartate transcarbamylase of Escherichia coli. A novel aspect of the methodology is the use of ^{14}C as a tracer to determine the isotope effect caused by ^{18}O alone, without the need for analysis by mass spectrometry. At optimum concentrations of carbamyl phosphate and L-aspartate and at pH 7.8 (near the pH optimum of the enzyme), the effect of ^{14}C at the carbonyl carbon or ^{18}O at the anhydride oxygen of carbamyl phosphate is very small. One possible explanation, but not the only one, is that kinetic steps in which the bonds to these atoms change are not important in determining the observed rate. Such an interpretation is consistent with a rate-determining conformational change of the enzyme at the pH optimum. At pH 10, where the activity of the enzyme is low, the rate with ^{14}C-labeled carbamyl phosphate is about 95% of the rate with the ^{12}C compound. On the other hand, no substantial effect is seen for ^{18}O in the anhydride position. Taken together, these observations indicate that a step in which the bonding to the carbon atom changes and the bonding to the anhydride oxygen does not change becomes important in the observed rate at pH 10. Such a process might be the formation of a tetrahedral intermediate. The solvent deuterium isotope effect in D_2O was also studied, at optimum concentrations of the substrates. The maximum velocity is essentially the same in D_2O and in H_2O. Thus, proton transfer does not seem to be involved in a rate-determining step in the aspartate transcarbamylase reaction. The pH activity profile of the enzyme is shifted up by about 0.8 pH unit in D_2O, and effect which can be accounted for approximately quantitatively by the expected change in the pK_α of the amino group of L-aspartate. (auth)

48513 REFLECTION AND ABSORPTION SPECTRA OF THE HIGHER $\pi \rightarrow \pi^*$ TRANSITIONS OF SOLID BENZENE. Brith, M. (Bar-Ilan Univ., Ramat Gan, Israel); Lubart, R.; Steinberger, I. T. J. Chem. Phys.; 54: No. 12, 5104-13(15 Jun 1971).

Reflection and absorption spectra of C_6H_6 and C_6D_6 were obtained at temperatures near 4.2°K, in the wavelength region of 1700 Å < λ < 2700 Å. The samples were prepared as films on a cold window. Well-resolved spectra were obtained with both methods. The reflectance data (obtained at near normal incidence) were converted, using a combination of Kramers–Kronig and curve-fitting techniques, to yield the real and imaginary parts of the dielectric constant as well as the refractive index and the absorption coefficient. The results were in good correspondence with those obtained by direct absorption measurements. The absorption bands observed below 2200 Å belong to the electronic transitions $^1A_{1g} \rightarrow {}^1B_{1u}$ ($\bar{\nu}$ < 50,000 cm^{-1}, weak system) and $^1A_{1g} \rightarrow {}^1E_{1u}$ ($\bar{\nu}$ > 50,000 cm^{-1}, strong system), respectively. The possible assignments of the individual bands within each system are discussed on the basis of the present results, taking into account conclusions derived from spectra of benzene embedded in rare-gas matrices. Semiempirical calculations are carried out on the shift of the different progressions within the $^1A_{1g} \rightarrow {}^1B_{1u}$ transition in the solid. (auth)

Physical Chemistry

Refer also to abstracts 48493, 49073, 51030, 51072, 51073, and 51141.

48514 CONDUCTIVITY IN CONCENTRATED AQUEOUS URANYL SALT SOLUTIONS. Kalman, Erika (Technische Univ., Dresden). Z. Phys. Chem. (Leipzig); 246: No. 1-2, 141-4(1971). (In German).

The specific conductivity for various uranyl salt solutions [$(UO_2(ClO_4)_2$, $UO_2(No_3)_2$, UO_2Cl_2, and UO_2SO_4)] was measured with a Wheatstone bridge. $UO_2(ClO_4)_2$ showed the highest conductivity when compared to other uranyl salt solutions. The lowest conductivity values were obtained with UO_2SO_4. Differences in conductivity were explained as the result of complexing. (H.B.G.)

48515 COMPARISON OF ISOTHERMAL ADSORPTION DATA BY THE TECHNIQUE OF ABSOLUTE ADSORPTION. Clough, P. S.; Dollimore, D.; Nicklin, T. (Univ. of Salford, Eng.). J. Appl. Chem. Biotechnol.; 21: No. 5, 137-40(May 1971).

A method of comparing adsorption data, obtained for samples within a series and having similar surface characteristics, is described. It is shown that the surface interaction with polar molecules increases quite markedly as the polar nature of the surface changes. The use of a nonpolar molecule established that the effects observed were genuine. The samples studied were prepared by impregnation of a commercial high-surface γ-alumina with solution of nickel and uranyl nitrates as part of a wider study into the nature of the surface involved in the nickel–uranium system. (auth) (UK)

48516 THERMODYNAMIC PROPERTIES OF PENTAFLUORIDES AT HIGH TEMPERATURES. IV. PENTAFLUORIDES OF 5f ELEMENTS. Galkin, N. P.; Tumanov, Yu. N.; Butylkin, Yu. P. Russ. J. Phys. Chem. (Engl. Transl.); 44: No. 12, 1726-7(Dec 1970).

Two possible structures are proposed for the pentafluorides of uranium, neptunium, and plutonium: a trigonal bipyramid and a tetragonal pyramid. The entropies and reduced free energies for these pentafluorides at p = 1 atm in the ideal gas state have been calculated in terms of the rigid rotator-harmonic oscillator approximation in the range 298 to 3200°K with the aid of the equivalent molecular constants for these structures. (auth)

48517 CHELATE FORMATION OF 4-CARBOXYCATECHOL WITH SOME METAL IONS. Jayadevappa, Ettigi S.; Renukarani, S.; Hukkeri, P. B. J. Karnatak Univ., 14: 64-71(1969).

Potentiometric titration curves were used to study the chelate formation of UO_2^{2+}, ZrO^{2+}, TeO_3^{2-}, Th^{4+}, and Tl^+ with 4-carboxycatechol, indexed as 2-phenyl-4-chromancarboxylic acid. The curves showed that all of the metal ions except Tl^+ formed chelates with this ligand. Except for the UO_2^{2+} ion, the equilibrium is very complex. The magnitude of the stability constants for the UO_2^{2+} chelates is similar to those of other dihydroxy ligands, such as 3,5-disulfopyrocatechol, rather than those of the dicarboxylic acids, such as malonic and succinic acids. (Selenium–Tellurium Abstr.)

48518 KINETICS OF SOME URANYL NITRATE-ORGANIC PHOSPHATE EXCHANGE REACTIONS. Egozy, Yair; Weiss, Shmuel (Nuclear Research Center-Negev, Beer-Sheva, Israel). J. Inorg. Nucl. Chem.; 33: 1451-6(May 1971).

The kinetics of the exchange reaction between uranyl nitrate–organic phosphate complex and excess phosphate was studied by NMR line broadening. The organic phosphates were tributyl, dibutyltolyl, and butylditolyl phosphate. The influence of solvents on rate constants was investigated, the order of the reaction was ascertained and activation energies were determined. The activation energy was the same, within experimental accuracy, for all three phosphates in all the solvents investigated (9 kcal/mole). Qualitative results were also obtained for the more bulky tris(2-ethylhexyl) phosphate, which was found to exchange at a lower rate than the above mentioned phosphates. The problems arising when it is attempted to use the rate constants of the exchange reaction to estimate the permeability of uranyl nitrate through solvent membranes containing the same phosphates are discussed. (auth) (UK)

Radiation and Nuclear Chemistry

Refer also to abstract 49101.

Radiation Effects

48519 (CEA-CONF-1763) ESR AND ENDOR STUDY OF HYDROGEN BOND PROPERTIES. BEHAVIOR OF THE GAMMA INDUCED RADICALS IN HYDROGEN BONDED CRYSTALS HAVING PROTONIC CONDUCTIVITY: IMIDAZOLE AND TRIAZOLE. Gloux, P.; Lamotte, B. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1970. 4p. (CONF-700960–2). Dep. NTIS (U. S. Sales Only).

From sixteenth AMPERE colloquium; magnetic resonances and related phenomena; Bucharest, Romania (1 Sep 1970).

By gamma irradiation of imidazole and triazole, three free radicals corresponding to the addition of a hydrogen atom on aromatic carbons were obtained. All the proton hyperfine tensors of the radicals were determined using ENDOR measurements at 100°K (type a protons, covalently bonded to the free radicals; type b protons, hydrogen bonded to the free radicals). Endor spectroscopy allows type b protons to be determined. (France)

48520 IONIZATION OF DIELECTRIC LIQUIDS BY GAMMA-RAY. Nakayama, Takeyoshi; Kawano, Minoru (Nagoya Univ., Japan). Oyo Butsuri; 40: No. 4, 358-64(Apr 1971). (In Japanese).

Some characteristics of ionization phenomena in dielectric liquids irradiated by γ rays from ^{60}Co were studied. Ionization current was measured with a parallel plate ionization chamber. In the chamber, not only the field intensity but also the electrode spacing could be changed independently. Applying Jaffé's theory on columnar recombination to the obtained characteristic curve of ionization, the saturated value of ionization current was estimated. The collection efficiencies for ions in several kinds of dielectric liquids were studied as a function of field intensity. The average energy per ion pair, W-value, for several kinds of dielectric liquids was estimated from the value of the saturation current from which the influence of secondary electrons emitted from the chamber wall was excluded. Using the W-value of carbon disulfide measured by Mohler and Taylor as the relative standard, the following W-values for dielectric liquids were obtained: n-hexane 25 eV; cyclohexane 22 eV; isooctane 22 eV; toluene 93 eV; carbon tetrachloride 54 eV; tetrachloroethylene 56 eV. (auth) (Japan)

48521 INFLUENCE OF IMPURITIES ON ACCUMULATION AND DESTRUCTION OF HYDROXYL RADICALS IN CRYSTALLINE ICE, γ-IRRADIATED AT 77°K. Puntezhis, S. A.; Ershov, B. G.; Pikaev, A. K. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR; 196: 641-4(Jan 1971). (In Russian).

Crystalline ice and frozen solutions containing LiOH, KOH, HF, and CH_3OH were irradiated at 77°K with ^{60}Co γ rays at a dose rate of 7×10^{15} eV/g sec. EPR spectra were taken in a thermostat to determine the destruction of paramagnetic centers. It was found that in pure ice the radical yield depends on the method of freezing. Thus the yield of hydroxyl radicals was 20 to 30% greater in ice obtained by rapid freezing at 77°K (G(OH) = 0.55) than in ice obtained by slow freezing (G(OH) = 0.7 to 0.8 radicals per 100 eV). The G(OH) values were 0.65 for 1.0 M LiOH, 0.75 for 1.0 M HF, and 0.70 for 1 M CH_3OH. The limiting concentration of radicals is obtained at a dose of about 10^{21} eV/g. The thermal destruction of hydroxyl radicals begins to take place at 103°K in crystalline ice. The destruction of OH radicals is described by a first-order equation. At 130°K the rate constants for the destruction of OH radicals were 0.0262 sec^{-1} for H_2O, 0.0195 for 0.1 M KOH, 0.0182 for 0.1 M LiOH, 0.0151 for 0.1 M CH_3OH, and 0.0145 for 0.1 M HF. The activation energy was found to be 5 kcal/mole, which is equal to the energy of a hydrogen bond. It is concluded that structural defects of crystalline ice have a noticeable effect on the initial yield of hydroxyl radicals and on the rate of radiation destruction of these radicals. The introduction of impurities increases the number of defects in ice, and this increase in defects leads to an increase in the rate of formation of hydroxyl radicals and to a decrease in the rate of destruction of these radicals by radiation. (TTT)

48522 OPTICAL ABSORPTION BANDS OF THE RADICAL IN IRRADIATED ANTHRACENE SINGLE CRYSTALS. Akasaka, Youichi; Murakami, Kouichi; Masuda, Kohzoh; Namba, Susumu (Osaka Univ.). Mol. Cryst. Liquid Cryst.; 13: No. 4, 377-80 (Jul 1971).

The correlation between the ESR spectrum and the optical absorption bands in the visible region was studied in an anthracene single crystal irradiated with a 1.5-MeV electron beam by the isochronal annealing method. The optical absorption bands were observed at 470, 500, 537, and 608 nm. Among these absorption bands, the band at 470 nm was found to be that of the radical produced by irradiation, which may be dibenzo-cyclohexadienyl radical. (auth) (UK)

Radiation Processes

Refer also to abstract 48706.

48523 POTENTIAL ROLE OF RADIATION IN WASTEWATER TREATMENT. Ballantine, David S.; Miller, Lowell A. (Atomic Energy Commission, Washington, D. C.). Chem. Eng. Progr., Symp. Ser.; 66: No. 104, 187-94(1970).

Application of nuclear radiation to the treatment of sewage problems is discussed. The characteristics of nuclear radiations and their interactions with aqueous and organic systems are reviewed. (auth)

48524 DESTRUCTION OF ORGANIC SUBSTANCES IN WASTEWATER BY IONIZING RADIATION. Compton, D. M. J. (Gulf General Atomic Inc., San Diego, Calif.). Chem. Eng. Progr., Symp. Ser.; 66: No. 104, 195-204(1970).

Oxidation and removal of organic impurities in waste waters using ionizing radiation is being studied, with particular attention to: the use of real waste waters and not synthetic mixtures; the use of careful control measurements since waste waters are live and change rapidly with time; the formulation of a theoretical model; and expressing the results in engineering units susceptible to economic analysis. (auth)

48525 OZONE SYNTHESIS FOR WATER TREATMENT BY HIGH ENERGY RADIATION. Steinberg, Meyer; Beller, Morris (Brookhaven National Lab., Upton, N. Y.). Chem. Eng. Progr., Symp. Ser.; 66: No. 104, 205-20(1970).

The synthesis of ozone by high-energy radiation is discussed. Ozone can be used effectively in reducing the chemical oxygen demand in tertiary treatment of secondary sewage waste effluent. Results of radiation chemistry studies and operation of the Brookhaven Chemonuclear In-Pile Research Loop indicated that ozone can be produced from oxygen in a high-pressure production facility. (auth)

48526 RADIATION INDUCED REACTIONS OF AQUEOUS POLYETHYLENE OXIDE SOLUTIONS. II. INTRINSIC VISCOSITY CHANGES IN THE PREGEL REGION. Stafford, J. W. (Leicester Coll. of Tech., Eng. Leicester Univ., Eng.). Makromol. Chem.; 134: 71-86(1970).

The significance of molecular weight changes induced by lower than gel dose irradiation on deaerated aqueous polyethylene oxide was studied. A model is proposed for the interpretation of molecular weight changes occurring in the pregel region of irradiated dilute aqueous polymeric systems. The model is, in principle, related to and gives results compatible with the molecular weight changes occurring during condensation polymerization. On the basis of the above model and the Zimm–Kilb theory of branching effects on intrinsic viscosity, calculated intrinsic viscosities agree satisfactorily with results for low-molecular-weight material only when allowance is made for intramolecular crosslinking and a drastic reduction in the rate of intermolecular crosslinking with dose for doses close to the gel dose. A similar quantitative approach is not possible for higher-molecular-weight material because of the high branching densities involved. A qualitative approach shows that many features of the radioinduced behavior of intrinsic viscosities can be explained by the proposed model. For concentrations below the critical concentration, a treatment based on diffusion control of intermolecular crosslinking was found to be satisfactory. (auth)

48527 RADIATION INDUCED REACTIONS OF AQUEOUS POLYETHYLENE OXIDE SOLUTIONS. I. THEORY OF GELATION. Stafford, J. W. (Leicester Coll. of Tech., Eng. Leicester Univ., Eng.). Makromol. Chem.; 134: 57-69(1970).

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Dilute deaerated aqueous polyethylene oxide solutions were irradiated with ^{60}Co γ rays. The concentration dependence of the gel dose, the dose required for gelation, was found to vary with the initial molecular weight of the polymer used. For low-molecular-weight polymer, with increasing polymer concentration the gel dose fell rapidly to its lowest value at the critical concentration, c_{crit}, and thereafter increased. High-molecular-weight material showed similar behavior below c_{crit}, but the gel dose varied little with addition of polymer for concentrations not far above c_{crit}. These results are interpreted in terms of a proposed theory which considers the intermolecular crosslinking process to be diffusion controlled below c_{crit}, and to depend on the packing of discrete, noninterpenetrating polymer molecules not far above c_{crit}. Literature data on the radioinduced gelation of deaerated aqueous poly(vinyl alcohol) solutions can also be satisfactorily treated with the proposed theory. (auth)

48528 ELECTRON IRRADIATION PROCESS AND PRODUCT. (to Armour-Dial Inc.). British Patent 1,239,476. 14 Jul 1971. Priority date 19 Jul 1967, United States.

A soap bar impregnated with a radiosensitive dye in a particular spot in a design or throughout the bar may be permanently identified by exposure to ionizing radiation. Suitable dyes for this process are azo dyes having a symmetrical arrangement of ring structures about the azo group. A continuous process apparatus for irradiating bars of soap with electrons is described. (B.L.M.)

48529 PROBLEMS OF RADIATIONAL SOLID-PHASE POLYMERIZATION OF AMORPHOUS VINYL ACETATE AND DIMETHACRYLATE OF BUTANEDIOL. Gusakovskaya, I. G.; Nikol'skii, V. G.; Gol'danskii, V. I. (Inst. of Chemical Physics, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 4: No. 5, 387-90(Sep-Oct 1970).

Translated from Khim. Vys. Energ.; 4: No. 5, 434-8(Sep-Oct 1970).

Radiothermal luminescence and heat evolution during the thawing of amorphous monomers of vinyl acetate (VA) and dimethacrylate of butanediol (BM) irradiated with γ-rays from ^{60}Co at $-196°C$ were investigated. When the irradiated specimens were subjected to optical bleaching at $-196°$ and then thawed, the intensity of radiothermal luminescence diminished for both monomers; also the heat evolution decreased in the temperature region of polymerization ($-142°$ for VA and $-92°$ for BM), and the yield of the polymers from bleached specimens was reduced. On the basis of these results, the assumption is postulated that ions participate in the initial stage of the polymerization of these monomers. It was found that during the thawing of irradiated monomeric specimens containing dissolved oxygen (about 4×10^{17} molecules per gram), the formation of a polymer occurred only in the case when the dosage exceeded 0.3 to 0.5 Mrad. The influence of the thawing rate on the yields and molecular weights of the polymers was investigated. With the increasing thawing rate the polymer yield dropped sharply. In the case of VA, the increase of the thawing rate resulted also in a decrease of the molecular weight of the polymer (the polymer of BM is insoluble; its molecular weight could not be determined). (auth)

48530 CHEMISTRY OF ORGANIC FLUORINE COMPOUNDS. IX. RADICAL ADDITIONS OF DIMETHYLISOPROPYLAMINE ON TRIFLUOROCHLOROETHYLENE. Liska, F. (Technische Hochschule, Prague). Coll. Czech. Chem. Commun.; 36: No. 5, 1853-9(May 1971). (In German).

The uv- or ^{60}Co-γ-initiated addition of dimethylisopropylamine to trichloroethylene gave the 1:1 adduct 4,5-dimethyl-1,2,2-trifluoro-1-chloro-4-azahexane and 3,3,4-trimethyl-1,2,2-trifluoro-1-chloro-4-azapentane and the 1:2 adduct 3,3,4-trimethyl-1,2,2,6,6,7-hexafluoro-1,7-dichloro-4-azaheptane. The PMR spectra are cited as evidence, and the reaction mechanisms are discussed. (tr-auth)

48531 RADIATION-INITIATED POLYMERIZATION OF MONOMERS DERIVED FROM ANABASINE, PIPERIDINE, AND THEIR DERIVATIVES. Musaev, U. N.; Babaev, T. M.; Azimov, A. A.; Tillaev, R. S.; Usamov, Kh. U. Acta Chim. Acad. Sci. Hung.; 67: No. 4, 403-10(1971). (In Russian).

The radioinduced polymerization of N-methacryloylpiperidine, N-acryloyl-2-methylpiperidine, N-acryloyl-2-methyl-5-ethylpiperidine and N-methacryloylanabasine was studied. Polymerization was carried out by gamma irradiation in block using dose rates of 16 to 305 rad/sec. The study of polymerization kinetics revealed that the polymer yield is increased by increasing amounts of absorbed dose. Among the monomers studied, the highest activity was found with N-methacryloylpiperidine. The polymer yield reaches 100% at low doses (0.1 to 0.2 Mrad). The derivatives of piperidine are less active. For example, the conversion of N-methacryloylanabasine remains below 15 to 20% under the conditions of N-methycryloylpiperidine polymerization. It was verified by ir spectroscopy that the polymerization of these monomers occurs at the vinyl double bond. The polymers obtained are soluble in water, in dilute acids and bases, and in the physiological solution. The physicochemical properties of the polymers were studied. (auth)

48532 ISOTOPES AND RADIATION TECHNOLOGY. VOLUME 8, NUMBER 4. Baker, P. S.; Rupp, A. F.; Gerrard, Martha; (and others) (eds.). One of Four Quarterly Technical Progress Reviews Published for the Division of Technical Information, USAEC. Oak Ridge, Tenn.; Oak Ridge National Laboratory (1971). 105p. GPO $0.70.

Twenty-five papers are included; ten have been abstracted individually for NSA. Topics of papers previously reported and therefore not abstracted individually for NSA are: nuclear techniques and the fight against pollution; activation analysis and sulur-isotope-ratio techniques for oil-slick identification; comparison of radioisotopes and fluorescent dyes for estuary pollution-control studies; tritiated water-vapor method for studying lake evaporation; measurement of sulfur dioxide in stack gases: design, fabrication, and test of demonstration instrument; kryptonate-based instrument for detecting automobile-exhaust pollutants; detection system for tracing radionuclide-labeled sediment in the marine environment; high-energy radiation synthesis of ozone for water treatment; conceptual design of an irradiation test facility for waste water and sewage sludge; radiation treatment of industrial waste waters: and economic analysis; gamma irradiation as a pretreatment to chemical precipitation in the purification of domestic sewage; and, destruction of organic substances in waste water by ionizing radiation. Miscellaneous subjects include: recent reports on pesticides, pollution problems, availability of isotopes and services, and abstracts of recent literature. (J.G.B.)

For abstracts of individual papers see: 48533–48537, 48667, 48674, 48752, 48753, and 49029.

48533 POTENTIAL ROLE OF RADIATION IN WASTE-WATER TREATMENT. Ballantine, D. S. (Atomic Energy Commission, Washington, D. C.). Isotop. Radiat. Technol.; 8: No. 4, 415-20(Summer 1971).

The potential role of radiation in the treatment of waste water is described. Interactions of radiation with both water and organic compounds are briefly presented, and dose requirements are discussed. The use of radiation to concentrate solids and destroy bacteria is also considered. Irradiation appears to have some attractiveness in increasing the sedimentation rate of solids; however, low reaction efficiencies of radiation in the destruction of waste materials (G values <10) indicate a cost greater than that for conventional technology in the treatment of sewage. (auth)

48534 SEWAGE AND WASTE-WATER PROCESSING WITH ISOTOPIC RADIATION: SURVEY OF THE LITERATURE. Gerrard, Martha. Isotop. Radiat. Technol.; 8: No. 4, 429-35(Summer 1971).

The literature on the use of ionizing radiation to process domestic and industrial liquid waste is reviewed. (65 references) (auth)

48535 BIOLOGICAL–GAMMA-RADIATION SYSTEM FOR SEWAGE PROCESSING. Mann, Leland A. (Energy Systems, Inc., Melbourne, Fla.). Isotop. Radiat. Technol.; 8: No. 4, 439-44(Summer 1971).

A biological–gamma-radiation method for purifying sewage at a cost competitive with that of conventional advanced treatments was developed, and a pilot plant and a commercial plant were designed, constructed, and tested. Settleable-solids concentration and turbidity are decreased, and a satisfactory biological oxygen demand (BOD) is maintained. Important improvements that are not economically feasible with conventional treatments alone are the destruction of almost all coliform bacteria, of some viruses, and of more than 90% of both biodegradable and nonbiodegradable detergents, with indication that algae do not grow in the effluent. Plants already in existence could be modified by the addition of irradiator and filter modules to increase system capacity and improve effluent quality. (auth)

48536 GAMMA IRRADIATION OF WATERS AND WASTE WATERS FOR DISINFECTION PURPOSES. Vajdic, A. H. Isotop. Radiat. Technol.; 8: No. 4, 451(Summer 1971).

Aqueous suspensions of Escherichia coli were sterilized by gamma irradiation much more rapidly in the presence of a low chlorine residual, but virus inactivation was not affected by up to 1.5 ppM chlorine. A chlorine residual of 1 ppM was decreased to a nondetectable level by irradiation with 4.0×10^4 rads. A gamma dose of 3.5×10^4 rads considerably decreased the threshold odor of water containing the taste and odor component produced by an actinomycete. (auth)

48537 GAMMA IRRADIATION OF RAW SEWAGE FOR SEDIMENTATION PURPOSES. Andrews, R. H.; Fielding, M. B. Isotop. Radiat. Technol.; 8: No. 4, 452-3(Summer 1971).

In preliminary tests, gamma (^{60}Co) irradiation of raw sewage did not consistently lead to improved settling. Settling of solids from domestic sewage was increased about 20% by a total radiation dose of 10^5 rads, but then was decreased sharply by higher doses, indicating degradation of the solids. In mixed sewage, improvement was only about 10% with this dose, and this also was followed by a short drop. Results were similar with the 630 rad/hr dose rate, the degradation occurring at about 10^5 rads. (auth)

48538 DECHLORINATION OF DDT IN SOLUTION BY IONISING RADIATION. Sherman, W. V.; Evans, R.; Nesyto, E.; Radlowski, C. (Chicago State Coll.). Nature (London): 232: No. 5306, 118-19(9 Jul 1971).

The feasibility of dechlorinating DDT solutions by exposure to ^{60}Co γ radiation was investigated. DDT is almost insoluble in water, and the bulk of DDT carried in contaminated water is probably dissolved in organic material, such as suspended liquid fats, soap or detergents, or adsorbed on microparticulates. In the studies described the DDT was dissolved in 2-propanol; this solvent was chosen since it had proved to be suitable in previous work on the mechanism of chain dechlorination of CU_4, which may be considered a structural model for DDT. Irradiation was conducted under anaerobic conditions and products identified were HCl, acetone and 1,1-dichloro-2,2-bis(p-chlorophenyl)ethane (DDD). Curves are given showing the effect of dose rate on dechlorination of the DDT. In order to determine whether the dechlorination involved free radical intermediates, radiolysis was carried out in the presence of small concentrations of free radical scavengers; dechlorination values were significantly reduced in all cases. The results were consistent with the same free radical chain mechanism as postulated for the CCl_4–2-propanol system (J. Phys. Chem., 74: 3043(1970)). It is concluded that while this may not be an economic way of treating water contaminated with DDT, it should offer a basis for further study. (UK)

48539 RADIATION HARDENABLE COATINGS. Blin, Marie-Francoise; Gaussens, Gilbert (to Commissariat a l'Energie Atomique). French Patent 2,030,505. 2 Nov 1970. Filed 31 Jan 1969. (In French).

A method for coating surfaces in the form of varnishes, painting, or various other materials is presented. This coating process utilizes a film-forming solution composed of a resin or a mixture of several unsaturated organic olefinic resins in one or several vinyl monomers. A copolymer is formed by ionizing radiation in the presence of air or a reducing atmosphere or one without oxygen. The total dose received by the coating is between 0.1 and 100 Mrads. (France)

Radiolysis

Refer also to abstracts 49080, 49099, 49104, and 49973.

48540 (AD–717243) PULSE RADIOLYSIS TECHNIQUES. Klein, Nathan; Rock, Theodore J. (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Nov 1970. 45p. (BRL–1508). NTIS.

The report deals with the development of advanced pulse radiolysis techniques. Design parameters for light sources, detectors, and data recording systems are discussed and an analytical array is described that makes possible the acquisition of spectral data with high sensitivity and nanosecond resolving time. (auth) (USGRDR)

48541 (LA–4658) RADIOLYSIS OF MIXTURES OF CARBON MONOXIDE AND HYDROGEN. Beattie, W. H. (Los Alamos Scientific Lab., N. Mex.). Oct 1969. Contract W-7405-eng-36. 17p. Dep. NTIS.

The self-radiolysis of mixtures of carbon monoxide (CO) and tritium ($^3H_2$) has been studied at pressures of 0.25 to 1.0 atmospheres, temperatures of −198 to +100°C, and in the presence of added H_2O or CO_2. The products of decomposition are CO_2, ^3H_2O, C^3H_4, $C_2{}^3H_4$, and a white polymer believed to be polyformaldehyde. Initial rates and G values were measured and compared with rates of ion pair formation. A mechanism for decomposition of CO and formation of products is presented. The initial rates are consistent with a mechanism involving a reaction between excited $^3H_2$ and CO to produce C^3H_4, CO_2, ^3H_2O, and a sequence of ion-molecule reactions to produce polyformaldehyde. (auth)

48542 (UCLA–12–815, pp 37-62) BIOCHEMISTRY. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology).

In Annual progress report June 30, 1971.

Progress is reported on the following: culture conditions and the myosin level in rat heart cells; myosin serum factor for rat heart cells; growth and myosin synthesis in rat heart cells; S-100 protein synthesis and degradation in clonal glial cell cultures; cell surface antigens of clonal glial cells; antisera to nerve endings; fine structural and growth characteristics of cultured rat liver cells; insulin effects; regulation of the pyruvate kinase of an established rat liver cell line in culture by insulin, glucose, and serum; degradation of insulin by cultured rat liver cells; regulation of the tyrosine ketoglutarate transaminase of rat liver cells by desamethasone and insulin; the alpha oxidation systems of brain microsomes; studies on blood brain barrier; wax ester lipases of marine animals; gamma radiolysis of carboxylic acids in condensed states; mechanism of the decarboxylation reaction and formation of aldehydes; and biosynthesis of unsaturated fatty acids by bacilli. (H.L.W.)

48543 (UJV–2552-Ch) RADIOLYSIS OF HALOGENATED HYDROCARBONS. I. THE CHROMATOGRAPHICAL DETERMINATION OF Cl_2 AND Br_2 PRODUCED BY RADIOLYSIS OF BINARY MIXTURES OF $CCl_4 + CBr_4$ AND $CCl_4 + Br_2$. Sistek, I.; Urban, J.; Skrceny, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). [nd]. 13p. Dep. NTIS (U. S. Sales Only).

A chromatographic method was elaborated for determination of free halogens in mixtures of halogenated hydrocarbons containing Cl and Br only. The method consists in the transformation of Cl_2 and Br_2 into dichloro-, dibromo-, and chlorobromocyclohexane by adding, under defined conditions, a corresponding quantity of cyclohexene to the mixture. The influence of various factors on this determination is discussed and the method is compared with the other methods available. The analysis of a sample takes about 25 minutes. (auth)

48544 (UJV–2562-Ch) RADIOLYSIS OF HALOGENATED HYDROCARBONS. II. THE CHROMATOGRAPHICAL DETERMINATION OF CARBON CONTAINING RADIOLYTICAL PRODUCTS OF BINARY MIXTURES OF $CCl_4 + CBr_4$ AND $CCl_4 + Br_2$. Sistek, I.; Urban, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). [1970]. 13p. Dep. NTIS (U. S. Sales Only).

A complex chromatographic method is described of determination of radiolytic carbonaceous products from various binary mixtures of polyhalomethanes CX_4 with free halogens X_2 (X = Cl or Br). Together with the method of determination of Cl_2 and Br_2, this method allows simple and complete analysis of all products of radiolysis of $CCl_4 + CBr_4$ or $CCl_4 + Br_2$ mixtures. (auth)

48545 RADICAL KINETICS IN THE VACUUM IRRADIATION OF POLY(VINYL CHLORIDE). Bartl, Anton (Zentralinstitut fuer Festkoerperphysik und Werkstofforschung, Dresden). Makromol. Chem.; 134: 169-77(1970). (In German).

A suspension of polymerized poly(vinyl chloride) (PVC/Sp) in powdered form was irradiated with gamma rays in vacuum at room temperature. The formation curve at room temperature and the decay of the radicals after the irradiation was measured in vacuum from 20 to 90°C. The G-value of the radical formation, the rate constants, and the activation energies of the radical decay were determined. Assuming a cage model of the radical recombination it is possible to explain satisfactorily the course of the kinetic curves in the investigated temperature range. (auth)

48546 RADIATION INDUCED REACTIONS OF AQUEOUS POLYETHYLENE OXIDE SOLUTIONS. IV. EFFECT OF ADDITIVES AS SELECTIVE SCAVENGERS. Stafford, J. W. (Leicester Coll. of Tech., Eng. Leicester Univ., Eng.). Makromol. Chem.; 134: 99-111(1970).

It was found that the effect of additives on the γ radioinduced reactions of aqueous polyethylene oxide solutions cannot be explained solely on the basis of competition between polymer and additive for hydrogen-abstracting radicals. Polymer–solvent and polymer–additive interactions were found to be important. Some systems studied were best described in terms of the effect of additive on the radiation chemistry of water and the action of products of additive–radical reactions on the polymer. Additives capable of influencing the ratio of intra to intermolecular crosslinking produced marked effects. The results indicate that polyethylene oxide is very reactive toward the hydroxyl radical, less so toward the hydrogen atom, and relatively inactive toward the solvated electron, although solvated electron scavengers increase the dose required to gel. (auth)

48547 RADIATION INDUCED REACTIONS OF AQUEOUS POLYETHYLENE OXIDE SOLUTIONS. V. SYSTEMS CONTAINING DIOXANE. Stafford, J. W. (Leicester Coll. of Tech., Eng. Leicester Univ., Eng.). Makromol. Chem.; 134: 113-19 (1970).

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The radioinduced variations in intrinsic viscosity for concentrated aqueous solutions of polyethylene oxide containing relatively high proportions of dioxane show features which may be indicative of additive effect on water–polymer interactions. In solutions more dilute in polymer and dioxane, the data can be treated in terms of competition between polymer and additive for hydrogen-abstracting radicals and competition between dioxanyl radicals and the crosslinking process for macroradicals. (auth)

48548 RADIATION INDUCED REACTIONS OF AQUEOUS POLYETHYLENE OXIDE SYSTEMS. III. RADIATION CHEMISTRY OF POLYETHYLENE OXIDE IN TERT-BUTYL ALCOHOL/WATER SYSTEMS. **Stafford, J. W. (Leicester Coll. of Tech., Eng. Leicester Univ., Eng.). Makromol. Chem.; 134: 87-97 (1970).**

A satisfactory explanation for the complex γ-radioinduced changes in polyethylene oxide in deaerated aqueous alcohol systems of relatively high alcohol content can be put forward only on the basis of both the radiation protection effect and water perturbation effect of the alcohol. Strong evidence was obtained in support of an earlier suggestion that preferential adsorption of alcohol by polyethylene oxide in aqueous solution occurs at low alcohol concentrations and decreases with increasing alcohol concentration. (auth)

48549 RADIATION-INDUCED DISLOCATIONS IN AMMONIUM PERCHLORATE CRYSTALS. **Herley, P. J. (Picatinny Arsenal, Dover, N. J.); Levy, P. W. Nature (London) Phys. Sci.; 232: No. 29, 66-8(19 Jul 1971).**

Exposure of ammonium perchlorate crystals to radiation before heating is known to accelerate the decomposition rate and the decomposition appears to be intimately related to dislocation production, a study of which is described employing ^{60}Co γ irradiation and cleaved single crystals. Examples of the qualitative effects produced by the irradiation are shown photomicrographically, including etch pit motion (1-butanol), stationary dislocations, movement of dislocations, etc. Doses below 10^5 R apparently did not produce additional etch pits, but above 10^5 R the pit concentration increased rapidly with dose, changing from $3 \times 10^5/cm^2$ to $15 \times 10^5/cm^2$ as the dose was increased from 10^5 to 10^6 R. Above 10^6 R the pit concentration was too large to estimate with reasonable accuracy and the pits overlapped extensively, with some areas markedly eroded. Mechanisms are suggested, including the role played by voids and gaseous decomposition products. It is considered reasonable to attribute part, if not all, of the radiation-induced increase in decomposition rate to the introduction of additional dislocations that can be described in terms of classical decomposition kinetics as an increase in concentration of decomposition nuclei. (UK)

48550 PHOTO-INDUCED REVERSIBLE HOLE TRANSFER IN A γ-IRRADIATED SINGLE CRYSTAL OF N-ACETYL-DL-METHIONINE: EXISTENCE OF TWO HOLE TRAPS IN A MOLECULE. **Kominami, S.; Akasaka, K.; Umegaki, H.; Hatano, H. (Kyoto Univ.). Chem. Phys. Lett.; 9: No. 6, 510-13(15 Jun 1971).**

A photoinduced reversible hole transfer between two kinds of hole-trap has been revealed in a single crystal of N-acetyl-DL-methionine γ-irradiated at 77°K. ESR evidence indicates that the deeper trap is a sulfur nonbonding orbital, whereas the shallower is a carbonyl π-orbital. (auth)

48551 MORPHOLOGICAL EFFECTS ON FORMATION AND BEHAVIOR OF RADICALS IN γ-IRRADIATED POLY-ETHYLENE SINGLE CRYSTALS. **Kusumoto, Naoshi; Yamamoto, Tateo; Takayanagi, Motowo (Kyushu Univ., Fukuoka). J. Polym. Sci., Part A-2; 9: No. 7, 1173-90(Jul 1971).**

Polyethylene single crystals differing in lamellar thickness, both as-grown and annealed with different lamellar thickness, were irradiated by γ rays to a dose of about 10^7 rad at liquid nitrogen temperature in vacuo, and then ESR measurements were made. It was found for the as-grown crystals that alkyl radicals were concentrated at the crystal surface. For the annealed crystals it was found that the radical concentration was greater than in the original crystals because of an increase in disorder with annealing. By assuming that the crystals form blocks upon annealing and that the surface and the interior of the blocks have the same trapping capacities for radicals as in the original crystals, the dependence of the size of the blocks upon variation in annealing temperature and the original lamellar thickness was estimated. This estimate is supported by the theory of the thickening process of single crystals. Two types of radical reactions with different reaction rates were found to occur simultaneously at room temperature. The rapid process was independent of lamellar thickness and was related to the reaction of radicals mainly in the surface region and the defects within the crystals. The slow process was strongly dependent on the lamellar thickness (i.e., the reaction rate was much depressed as the lamellar thickness was increased) and was inferred to be closely related to molecular motions manifested in viscoelastic measurements by the crystalline dispersion α_c. (auth)

48552 THERMORADIATION EFFECTS ON CERTAIN PROPERTIES OF CHLOROPRENE RUBBERS. **Arshakuni, R. G.; Mkrtchyan, R. A.; Gabrielyan, G. A.; Gol'din, V. A. (Inst. of Physical Investigations, Erevan). Arm. Khim. Zh.; 22: No. 7, 641-3(1969). (In Russian).**

Polychloroprene rubbers were exposed to γ doses from 0.9 to 1.8 MRAD at 65 to 70°C in air and a sharp increase in solubility was observed. This resulted from a destruction of the macromolecules of polychloroprene rubbers along sulfur and carbon–carbon bonds. The degree of destruction depended on the branching of the chloroprene rubbers. (tr-auth)

48553 RE-EXAMINATION OF THE YIELDS IN THE HIGH DOSE RATE RADIOLYSIS OF GASEOUS AMMONIA. **Boyd, A. W.; Willis, C.; Miller, O. A. (Chalk River Nuclear Labs., Ont.). Can. J. Chem.; 49: 2283-9(1 Jul 1971). (AECL-3894).**

Eyre and Smithies [Trans. Faraday Soc., 66: 2199-2209(1970)] have recently obtained radical yields of $G_{NH_2} = G_H = 10.4$ in the electron radiolysis of gaseous ammonia. The consistency of these with N_2, H_2, and N_2H_4 yields obtained in the high dose rate radiolysis of NH_3 and $NH_3-C_3H_6$ mixtures was shown by numerical integration of the rate expressions in a simple radical mechanism. These calculations give a value of $2.1 \pm 0.5 \times 10^{10}$ M^{-1} s^{-1} for the reaction of H atoms and NH_2 radicals and a ratio of recombination to disproportionation of 6:1. (auth) (Canada)

48554 FREE-ION YIELD IN THE RADIOLYSIS OF DIMETHYL SULFOXIDE. **Cooper, T. K.; Walker, D. C. (Univ. of British Columbia, Vancouver). Can. J. Chem.; 49: 2248-53(1 Jul 1971).**

Dimethyl sulfoxide is a dipolar aprotic solvent of high basicity having a large dielectric constant ($\epsilon = 48$) but very low solvating power for negative ions. The γ radiation yield of free ions in this liquid is in accord with the dielectric constant, G(free ions) = 1.8 ± 0.2, but these free ions do not resemble the strongly solvated electrons found in other polar media such as water and aliphatic alcohols. Evidence for this conclusion is based principally on competitive reactions involving a wide range of scavengers in competition with nitrous oxide. The radiation yields of gaseous products from pure liquid dimethyl sulfoxide are $G(H_2) = 0.20 \pm 0.01$, $G(CH_4) = 3.3 \pm 0.1$, and $G(C_2H_6) = 0.49 \pm 0.03$. (auth) (Canada)

48555 UNSTABLE INTERMEDIATES. PHYSICAL AND CHEMICAL PROPERTIES. **Fiti, Maria (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Chim.; 19: No. 3, 263-82 (Mar 1971). (In Rumanian).**

The true mechanism involved in the chemical actions of radiations may be fully clarified only if the unstable intermediates that appear as the precursors of the final reaction products are fully identified. During the last 10 years many attempts have been made to study these products which have a lifetime of 10^{-7} to 10^{-3} sec. From the large number of these products, those presenting a special chemical interest have been selected for closer study. The items described include the solvated electron, formed in water and other polar systems by irradiation; the hydrogen atom, the optical spectrum of which is not well suited for study and therefore has been investigated primarily by indirect methods; the hydroxyl radical, the main oxidizing species formed in the radiolysis of water by the decomposition of the H_2O^+ ion; and other inorganic intermediates formed by the reaction of oxyanions with the OH radical. The rich literature of the formation of organic intermediates is also examined briefly. (110 references). (TTT)

48556 RADIOLYSIS OF POLYSILOXANE RESIN. **Belova, V. V.; Pridachina, N. N.; Popova, A. I.; Serenkov, V. I. Plast. Massy; No. 3, 24-6(1971). (In Russian).**

Structural rearrangements occurring in solidified silicon organic resin under the influence of ionizing radiation were studied by ir spectroscopy, mass spectroscopy, thermomechanical, and physicomechanical techniques. Polymethylsiloxane resin is formed by cohydrolysis of methyltrichlorosilane and dimethyldichlorosilane yielding cyclic polymers with silsesquioxane bonds. It was determined that radiation leads to further structuralization of already solidified polymer. This is due to the formation of new ≡ Si-O-Si ≡ bonds, methylene and ethylene bridges, and changes in the cyclic structure pattern of the polymer. These polymers become more durable because of the disappearance of organic radicals and increase in the number of trimer cycles. Temperature increase during radiolysis enhances the rate and degree of these processes. (JPRS)

48557 DECOMPOSITION OF ADENINE BY IONIZING RADIATION. Van Hemmen, J. J.; Bleichrodt, J. F. (National Defence Research Organization TNO, Rijswijk, Netherlands). Radiat. Res.; 46: N o . 3, 444-56(Jun 1971).

After irradiation of adenine in aqueous solution, with γ rays in the absence of oxygen, six radiation products have been found and adequately separated from each other. Two of these are formed with a relatively low yield (G < 0.1) and do not show any remainder of the original adenine uv absorption spectrum. One of the other components is a secondary radiation product. From experiments with several radical scavengers it was concluded that 8-hydroxyadenine is formed via OH radicals, while for the formation of 4, 6-diamino-5-formamidopyrimidine no solvated electrons are required. 6-amino-8-hydroxy-7,8-dihydropurine is found only under conditions where electron adducts of adenine are formed. Reaction schemes for the production of these compounds are proposed. Experiments with ^{3}H- and ^{14}C-adenine as tracers show clearly that in the anoxic radiolysis of adenine reconstitution reactions occur, which give rise to the formation of water and repair of adenine radicals. It is shown that even in the presence of oxygen some kind of reconstitution must occur. (auth)

48558 MEASUREMENT OF THE YIELD OF HYDRATED ELECTRONS IN γ-RADIOLYSIS IN NEUTRAL WATER WITH THE NITRATE–METHANOL SYSTEM. Zansokhova, A. A.; Zhestkova, T. P.; Pikaev, A. K. (Inst. of Physical Chemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 4: No. 5, 406-7(Sep-Oct 1970).

Translated from Khim. Vys. Energ.; 4: No. 5. 454-5(Sep-Oct 1970).

The initial radiation yields of radical products in the radiolysis of neutral water were studied. Solutions of sodium nitrate with concentrations from 5×10^{-5} to 2.5×10^{-3}M, containing 0.1M methanol (pH of the solutions equal to 4.6), were investigated. The solutions, degasified or saturated with oxygen, were irradiated up to a dose of 2 to 4×10^{17} eV/ml · sec. The yields of nitrite and hydrogen peroxide were determined. The method of competitive acceptors was used to calculate $G_{e^-_{aq}}$. (auth)

48559 INVESTIGATION OF THE DESTRUCTION OF FREE RADICALS IN CRYSTALLINE PHENOL, ANILINE, N-ETHYLANILINE, AND o-NITRO-N-METHYLANILINE. Tolkachev, V. A.; Sokolov, I. B.; Kovalevskii, V. I. (Inst. of Chemical Kinetics and Combustion, Novosibirsk, USSR). High Energy Chem. (USSR) (Engl. Transl.); 4: No. 5, 407-8(Sep-Oct 1970).

Translated from Khim. Vys. Energ.; 4: No. 5, 455-6(Sep-Oct 1970).

In a large number of molecular crystals, in which the molecular mobility is frozen, wide temperature regions of destruction of free radicals produced by irradiation are observed, while the kinetics of their destruction is stepwise. These principles can be explained on the basis of the hypothesis of unfreezing of the molecular mobility close to defects of the crystal structure. However, the experimental data did not permit a sufficiently substantial comparison of this hypothesis with others already available in the literature. The purpose of this work was to make such a comparison. The curves of the annealing of radicals for the substances studied are cited. In ethylaniline at 200°K, and in nitromethylaniline at 260°K, the equilibrium concentration of radicals is ~50%. In aniline in the low-temperature region of destruction (100 to 230°K), ~80% of the radicals are destroyed, while in phenol at temperatures up to 260°K, the radicals are almost entirely destroyed. Hypotheses that might be used in an attempt to explain the experimental results are discussed. On the basis of measurements of the dielectric constant for substances of the same degree of purity, the upper limits of the fraction of the liquid phase in ethylaniline up to 200°K, in phenol and nitromethylaniline up to 260°K, and in aniline up to 250°K, which should appear as a result of the presence of impurities, were estimated. Special experiments based on the results led to the conclusion that the destruction of radicals should not be attributed to rearrangements of metastable formations, which in these cases might have been formed on account of the insufficiency of time for crystallization of the substances during the preparation of the samples. Estimates of the frequencies of the molecular mobility also do not permit an explanation of the kinetic data on the times of establishment of an equilibrium concentration of radicals under isothermal conditions, if the radicals are considered to be distributed approximately uniformly through the substance. It becomes possible to explain the data obtained if we assume that ~50% of the radicals in ethylaniline and nitromethylaniline (radicals destroyed at temperatures up to 200 and 260°K, respectively), 80% of the radicals in aniline (radicals destroyed in the low-temperature region), and 100% of the radicals in phenol are stabilized close to defects, and their destruction is due to unfreezing of the molecular mobility close to defects. This interpretation is in qualitative agreement with the results of estimates of the frequencies of molecular mobility close to defects from the data. The results obtained are also discussed from the standpoint of stabilization of radicals close to defects formed during irradiation. (auth)

48560 PULSE RADIOLYSIS STUDIES OF ACETONE SOLUTIONS OF BIPHENYL AND ANTHRACENE: FORMATION OF IONS AND EXCITED SINGLET STATE. Arai, Shigeyoshi; Kira, Akira; Imamura, Masashi (Inst. of Physical and Chemical Research, Yamato, Japan). J. Chem. Phys.; 54: No. 12, 5073-81 (15 Jun 1971).

The radiolysis of acetone solutions of biphenyl and anthracene was studied by means of the microsecond-pulse technique. Transient spectra, as well as the effects of ion scavengers, show the presence of both positive and negative ions of biphenyl and anthracene in irradiated solutions. Assuming that molar extinction coefficients of positive and negative ions are identical, one can determine the yields of ions to be $G(\text{biphenyl}^+ + \text{biphenyl}^-) = 1.1$ at 0.69M, and $G(\text{anthracene}^+ + \text{anthracene}^-) = 1.5$ at concentrations above 5×10^{-3}M. Decay kinetics of aromatic ions fit the second-order rate law, which can be ascribed to the charge neutralization reaction between the positive and negative ions; rate constants are found to be $k(\text{biphenyl}^+ + \text{biphenyl}^-) = 3.9 \times 10^{11}\text{M}^{-1} \cdot \text{sec}^{-1}$ and $k(\text{anthracene}^+ + \text{anthracene}^-) = 2.6 \times 10^{11}\text{M}^{-1} \cdot \text{sec}^{-1}$. The light emitted upon irradiation of acetone solutions of anthracene is anthracene fluorescence; a part of fluorescence is delayed. The relation between the intensity of fluorescence and the concentration, as well as the comparison of the energy level of anthracene with that of acetone, suggests the occurrence of energy transfer from the first excited singlet state of acetone to anthracene. The rate constant of energy transfer was estimated to be $6 \times 10^{10}\text{M}^{-1} \cdot \text{sec}^{-1}$. The yield of excited singlet anthracene was determined to be $G(^1\text{anthracene}) = 0.31$ at the concentration of 1.0×10^{-2}M. Addition of various ion scavengers to acetone solutions of anthracene reduced the yields of both excited singlet and triplet anthracene. These results may be explained by the reactions of ion scavengers with the primary ions in spurs. Thus these reactions result in the decreases in the yields of excited acetone which may be produced by geminate recombination. (auth)

48561 EFFECT OF SULPHYDRYL DISSOCIATION ON FREE RADICALS STABILIZED BY γ-IRRADIATED FROZEN AQUEOUS SOLUTIONS OF CYSTEAMINE. Copeland, E. S.; Earl, W. L. (Walter Reed Army Inst. of Research, Washington, D. C.). Int. J. Radiat. Biol.; 19: No. 4, 401-4(1971).

The type of free radicals formed in the solute of frozen aqueous cysteamine (or mercaptoethylamine [MEA]) solutions by γ irradiation at 77°K, was dependent on the degree of dissociation of the mercapto group of MEA before freezing. At pH 2, the last stable radical on annealing at 178°K and 198°K was the organo-sulphur radical RCH_2S, but at pH 9, an unidentified radical giving rise to a triplet ESR spectrum was observed. The triplet was tentatively identified as resulting from RS or $RSSR^-$, both of which gave triplets with appropriate g-values and splittings. Evidence for the participation of RS^- in the formation of the triplet species was obtained from a plot of the relative total radical yield at 77°K and relative radical stability after annealing at 133 and 193°K versus prefreezing pH; both the curves closely resembled the MEA zwitterion ($NH_3 + CH_2CH_2S^-$) concentration curve plotted as a function of pH. (UK)

Radioisotope Production

Refer also to abstract 48732.

48562 PREPARATION OF HIGH SPECIFIC ACTIVITY ^{51}Cr. Kim, Taeyoung; Kim, Young Kuk. J. Korean Nucl. Soc.; 3: No. 1, 15-19(Mar 1971).

A new preparation method for high-specific-activity ^{51}Cr has been developed by adding 0.1N NaOH and C_2H_5OH to the irradiated target solution of K_2CrO_4 to precipitate Cr*(III) without any scavenger such as Fe(III). The new method gives the product of higher specific activity and better yield than that of other methods, in the shorter processing time. This method is compared with the conventional method and the French method, and the following results are obtained: the new method gives specific activity more than twice that of the conventional method and better yield than the conventional method; the French method and the new method give similar specific activity, but yield of the new method is almost twice that of the French method. (auth)

48563 PRODUCTION OF RADIOACTIVE ^{137m}Ba. (to Union Carbide Corp.). British Patent 1,231,159. 12 May 1971. Priority date 28 Aug 1968, United States.

A process for producing radioactive ^{137m}Ba comprises forming an elutable substrate by contacting either a nickel, zinc, iron(II),

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or copper(II) cobalt ferrocyanide with a solution containing ^{137}Cs and selectively extracting the substrate with an eluent to separate ^{137m}Ba from its radioactive parent ^{137}Cs, which is deposited on the substrate. A physiological saline solution is a suitable eluent. A radioactive isotope generator comprising a substrate containing a reducing agent supported on a filter and entrance and exit means for the eluting solution for eluting the substrate is described in detail. (B.L.M.)

Recoil Production and Reactions

48564 NUCLEAR RECOIL IN SOLIDS AND KNOCKOUT EFFECT. Zimen, K. E.; Mertens, P. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Naturforsch.; 26a: No. 4, 773-5(Apr 1971). (In German).

With Hahn's emanation method, recoil and knockout effects were studied theoretically and experimentally for radon isotopes precipitated on solids. It was concluded that probability of noble gas release is not caused by recoil but by the knockout effect. This effect, within the region of the recoil funnel, transforms the lattice atoms into a quasi-gaseous state. Thereby, some lattice atoms are actually evaporated while others condense. (H.B.G.)

48565 NUCLEAR RECOIL REACTIONS IN ORGANO-MANGANESE COMPOUNDS. V. -$Mn(CO)_5$ TARGET COMPOUNDS. Jakubinek, H.; Srinivasan, S. C.; Wiles, D. R. (Carleton Univ., Ottawa). Can. J. Chem.; 49: 2175-82(15 Jun 1971).

$HMn(CO)_5$, $DMn(CO)_5$, $CH_3Mn(CO)_5$, and $C_6H_5Mn(CO)_5$ were irradiated with neutrons and the product spectrum of ^{56}Mn-containing molecules determined. The results show that $H^{56}Mn(CO)_5$ is formed in all cases: 21.0%, 23.6% from $HMn(CO)_5$ and $DMn(CO)_5$ targets, respectively, and 6.9% and 2.1% from $CH_3Mn(CO)_5$ and $C_6H_5Mn(CO)_5$, respectively. Thus the yields are not in accord with the number of H atoms per target molecule. Preliminary experiments show that $\cdot^*Mn(CO)_5$ exchanges rapidly with $HMn(CO)_5$ and $DMn(CO)_5$ and very slowly with $CH_3Mn(CO)_5$ and $C_6H_5Mn(CO)_5$. It is deduced that the very high yield of $H^{56}Mn(CO)_5$ in $HMn(CO)_5$ and $DMn(CO)_5$ targets could arise from the rapid exchange, while the lower yields of $H^{56}Mn(CO)_5$ in other targets must likely come from radical reactions following thermal dissociation of the target molecule. (auth) (Canada)

Separation Processes

Refer also to abstracts 48438, 48456, 48506, 48614, 49205, 51075, and 51110.

48566 (AECD/CH-13) SYNERGISM AND ANTAGONISM IN THE SOLVENT EXTRACTION OF THORIUM WITH MIXED SOLVENTS. Awwal, M. A.; Ali, K. M. Idriss (Atomic Energy Centre, Dacca (Pakistan)). Oct 1970. 11p. Dep. NTIS (U. S. Sales Only).

The extraction of thorium with four pairs of solvents such as TOPO-TTA, TOPO-PrJMT, TBP-PrJMT, and TOPO-TBP has been investigated as a function of different extraction parameters. (PrJMT refers to a mixture of primary tert-alkylamines containing alkyl groups of 12 to 24 carbon atoms.) The distribution coefficient of thorium has been studied with individual solvents as a function of nitric acid concentration. Then the distribution coefficient with mixed solvents has been investigated as a function of nitric acid concentration. Extraction of thorium as a function of single solvent concentration in the presence of constant solvent concentration of the pair from constant aqueous phase acid has been studied, and the effect of the solvent on the extractable metal complex is discussed. Both synergic and antagonistic effect in the solvent extraction of thorium with mixed solvents are reported. (auth)

48567 (BNWL-1583) WASTE SOLIDIFICATION PROGRAM. VOLUME 8. SPRAY SOLIDIFICATION PERFORMANCE DURING FINAL RADIOACTIVE TESTS IN WASTE SOLIDIFICATION ENGINEERING PROTOTYPES. Bond, W. R.; Hartley, J. N.; Mendel, J. E.; McElroy, J. L.; Thompson, R. J. (Battelle Pacific Northwest Labs., Richland, Wash.). Jun 1971. Contract AT(45-1)-1830. 296p. Dep. NTIS.

An in-pot melting modification of the spray solidification process (spray-calcined waste fused directly in the final storage container without need for separate melter) was successfully demonstrated. High-level aqueous radioactive waste was processed at overall rates of 11 to 18 liters/hr. The equivalent processing rates ranged from 0.50 to 1.1 tonnes/day of original fuel. From 35 to 75% of the total ruthenium fed to the solidifier was volatilized from the solidifier while processing waste solutions containing phosphoric acid as a melt forming additive and less than 2% of the ruthenium was volatilized with wastes not containing phosphoric acid when the in-pot melting modification was used. Entrainment of nonvolatiles from the solidifier was routinely less than 0.1%. Volatilized and entrained material from the solidifier was further treated in the WSEP auxiliary process equipment. The radionuclide content in the final aqueous liquid effluent was decontaminated by a factor of 10^9 for nonvolatiles and 10^5 to 10^6 for radioruthenium to concentrations that initial studies indicate are acceptable for recycle to a fuel reprocessing plant or for low-level treatment processes. (auth)

48568 (BNWL-1588) NEPTUNIUM AND ZIRCONIUM EXTRACTION UNDER PUREX HA COLUMN SCRUB SECTION CONDITIONS. Swanson, J. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1971. Contract AT(45-1)-1830. 21p. Dep. NTIS.

Distribution coefficients of zirconium and neptunium were measured to define conditions for increasing neptunium recovery while maintaining adequate decontamination from zirconium. Addition of a small amount of fluoride was effective in maintaining adequate zirconium decontamination when neptunium recovery was increased by increasing the nitric acid concentration or by decreasing the uranium concentration. (auth)

48569 (IN-1486) CHARACTERISTICS OF RADIOACTIVE ZIRCONIA CALCINE AFTER HEATING TO HIGH TEMPERATURE. Wilding, M. W.; Rhodes, D. W. (Idaho Nuclear Corp., Idaho Falls). Jun 1971. Contract AT(10-1)-1230. 12p. Dep. NTIS.

Laboratory experiments were conducted to determine the major physical and chemical changes occurring in zirconia-type calcine from the Waste Calcining Facility at the Idaho Chemical Processing Plant when heated in the range 800 to 1350°C. Samples of the calcine heated to simulate storage at various temperatures were examined by x-ray diffraction to detect changes in the crystalline structure. Samples heated to 1200°C were leached with distilled water at ambient temperature for 2000 hours to determine the leachability of the chemical and radiochemical constituents. The granular calcine formed a sintered mass at 800°C or higher. The major changes resulting from this sintering were a decreased leachability of the strontium in water and a significant volatility of the cesium and fluoride during heating at the higher temperatures. (auth)

48570 (NP-18919) DECONTAMINATION OF RADIOACTIVELY CONTAMINATED WATER WITH PEAT FILTERS. Bezzegh-Galantai, Maria Magdolna (Eidgenoessische Technische Hochschule, Zurich (Switzerland)). 1970. 45p. (In German). (DISS-4376). Dep. NTIS (U. S. Sales Only).

Experiments were carried out with the objective to determine the decontamination of rain and model water containing $^{90}Sr-^{90}Y$, and ^{131}I by various peats. The chemical composition of the model water was similar to rain or cistern water. Peat samples were taken in the Jura mountains, Neuchâtel region, Switzerland. Percolation experiments were carried out in laboratory ion-exchange columns of the usual dimensions and in pilot scale installations to determine the decontamination capacity of three types of peat. Good decontamination effects were determined for $^{90}Sr-^{90}Y$. The main parameters influencing the breakthrough capacity are: type of peat, degree of drying and deep freezing. A measurable retention of anionically available ^{131}I was observed at extremely low concentrations only ($<10^{-9}$ Mol NaI/liter). Retention increases exponentially with increasing dilution ratios. A solution of $<10^{-12}$ Mol Na ^{131}I/liter showed a retained activity of 60 to 90% related to the inflowing solution. The experiments yielded useful findings with regard to soil science. Particularly interesting are the irreversible structure changes of peat due to deep freezing and drying, and the correlation between calcium content or degree of decomposition and exchange or breakthrough capacity for cations. (auth)

48571 HAFNIUM(IV) EXTRACTION. XI. STABILITY OF HAFNIUM(IV) OXALATE COMPLEXES. Navratil, O.; Smola, J. (Purknye Univ., Brno). Collect. Czech. Chem. Commun.; 36: No. 4, 1659-64(Apr 1971). (In German).

The question was studied whether mixed complexes of the type $Hf(C_2O_4)A_2$ exist, in which A represents the residue of an organic reagent which extracts tetravalent metals. Composition and stability of the hafnium oxalate complex were determined by means of the ligand competition method. From the experimental data, stability constants were obtained by computer. The calculations showed that in the aqueous phase of the system studied only complexes of the following composition existed: $Hf(C_2O_4)^{2+}$ and $Hf(C_2O_4)_2$. (H.B.G.)

48572 EXTRACTION CHROMATOGRAPHY USING CHELATING AGENTS. II. SEPARATION OF SOME RADIOISOTOPES BY DITHIZONE. Sebesta, F. (Technical Univ., Prague). J. Radioanal. Chem.; 7: No. 1, 41-7(Jan 1971).

The separation of Zn–Cd, Ag–Hg, Cd–Ag, and Pb–Bi–Po by extraction chromatography in the system dithizone–carbon tetrachloride is reported. It was found that it is possible to calculate optimum conditions for the separation of the metals from the extraction constants of the metal chelates and the stability constants of the metal complexes with masking agents. (auth)

48573 ION EXCHANGE STUDIES WITH ZIRCONIUM PHOSPHATE, ZIRCONIUM TUNGSTATE. AND ZIRCONIUM MOLYBDATE: APPLICATION TO THE SEPARATION OF Na^+, Rb^+, AND Cs^+ IN NH_4Cl SOLUTION. Sanchez Batanero, Pedro (Univ., Madrid); May, Serge. Bull. Soc. Chim. Fr.: No. 5, 1935-9(May 1971). (In French).

The distribution coefficients of the alkali metals Na^+, Rb^+, and Cs^+ in zirconium phosphate, zirconium tungstate, and zirconium molybdate in ammonium chloride were studied. The separation factors for these three cations were measured. Separation of the three alkali metals was achieved using a column of zirconium molybdate with solutions of ammonium chloride. (France)

48574 STUDY ON THE SEPARATION OF THORIUM FROM URANIUM BY ION EXCHANGE. Zaharescu, T. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Chim.; 16: No. 5, 775-8(May 1971).

In order to separate thorium from uranium, two different methods involving ion exchange were used. The first method uses cation exchange resins, Dowex 50 × 8 and Amberlite IR-120 and the other one, anion exchange resins, Dowex 1 × 16 and Amberlite IRA-400. Both procedures are effective, but at the low concentrations of the components in the initial mixture, the second procedure is faster than the first. Similar results were obtained with higher concentrations of the two ions. (auth)

48575 DIFFUSION OF ^{99m}Tc IN NEUTRON IRRADIATED MOLYBDENUM TRIOXIDE AND ITS APPLICATION TO SEPARATION. Tachimori, Syoichi; Nakamura, Haruto; Amano, Hiroshi (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 8: No. 6, 295-301(Jun 1971).

The dry distillation method was studied for rapid separation of ^{99m}Tc from neutron-irradiated MoO_3. Upon heating, ^{99m}Tc produced in MoO_3 crystal by the $^{98}Mo(n,\gamma)^{99}Mo \xrightarrow{\beta^-} {}^{99m}Tc$ process was found to be released by diffusion. From observations made of the deposition temperature, it was concluded that ^{99m}Tc was present in the form of $^{99m}Tc(IV)$ in the MoO_3 crystal lattice and that it was released in the form of $^{99m}TcO_2$, which, in air, further oxidized to $^{99m}Tc_2O_7$. The release of ^{99m}Tc from neutron-irradiated MoO_3 powder was studied in the temperature range of 480° ~ 700°C, and its behavior was found to be in good agreement with the bulk diffusion mechanism based on Fick's law. The diffusion coefficient varied with temperature in compliance with Arrhenius' relation, except at temperatures above 700°C. The separation of ^{99m}Tc from MoO_3 was performed with a yield higher than 80% upon heating for 30 min at 800°C in air. The decontamination factor for ^{99}Mo was consistently found higher than 10^5. (auth)

48576 BENEFICIATION OF EUXENITE ORE. (to Nuclear Fuel Services, Inc.). British Patent 1,240,170. 21 Jul 1971. Priority date 8 Sep 1967, United States.

A process for separating Nb, Ta, Y, U, Th, and the lanthanide rare earths from euxenite ore consists of an alloying process with Fe in the presence of an oxidizing agent to form Fe–Nb and Fe–Ta alloys in a lower molten alloy layer and a slag containing the other desired elements. After separation of the two layers and solidification of the slag, an acidified solution of the slag can be contacted with a suitable extractant to separate U. Adjustment of the pH of the raffinate to 3 to 4 and filtration of the raffinate separates Th as the hydroxide from a filtrate containing Y and the rare earths. These can be recovered by precipitation and filtration. (B.L.M.)

48577 METHOD AND DEVICE FOR PROCESSING IRRADIATED FUEL ELEMENTS. (to Saint-Gobain Techniques Nouvelles). British Patent 1,238,052. 7 Jul 1971. Priority date 19 Jun 1967, France.

An apparatus is described for processing an irradiated fuel element having two inert ends and a body containing nuclear fuel enclosed in a cartridge or sheath. The element is conveyed from a storage place to a shearing machine, and the inert ends are removed during the course of conveyance. The cartridge or sheath is cut and sheared into pieces in the shearing machine, and the pieces are placed in a liquid for dissolving the nuclear fuel. (B.L.M.)

48578 PROCESS FOR SEPARATING RARE EARTHS. Chiola, Vincent; Cleveland, Joseph J.; Kamin, George J. (to Sylvania Electric Products Inc.). U. S. Patent 3,582,264. 1 Jun 1971. Filed 16 Sep 1969.

In the process for separating the lighter rare earth elements from heavier rare earth elements, an aqueous feed stream containing a mixture of both lighter and heavier rare earth elements flows through a number of extraction stages, and an organic extractant solution that preferentially extracts the heavier rare earth elements flows countercurrent to and in contact with the aqueous feed stream. The resulting loaded organic solution is separated from the aqueous solution, scrubbed with an aqueous scrub solution, separated from the scrub solution and used as a feed for further separation. An improvement is achieved by adjusting the pH of the scrub solution after the scrubbing step to between about 5 and about 7 and adding the adjusted scrub solution to an extraction stage downstream from the feed solution entry stage. Improvements in extraction and scrubbing efficiency are achieved. (Offic. Gaz.)

48579 PREVAILING MECHANISMS IN THE EXTRACTION OF MOLYBDATOPHOSPHORIC ACID AND CESIUM MICROAMOUNTS IN NITROBENZENE. Rais, J. (Institut fuer Kernforschung, Rez, Czech.). Collect. Czech. Chem. Commun.; 36: No. 4, 1665-9(Apr 1971). (In German).

The distribution of molybdophosphoric acid and of microamounts of cesium was studied between water and nitrobenzene. Molybdophosphoric acid, within a wide concentration range, enters the nitrobenzene phase as a monovalent anion, and behaves like a strong monobasic acid. The extraction constant of cesium molybdophosphate, in comparison to molybdophosphoric acid, was higher by approximately three orders of magnitude. This is a brief review of work done by the author and others with some theoretical considerations. No new data are presented. (H.B.G.)

48580 CURRENTLESS ENRICHMENT POSSIBILITIES OF TRACE METALS ON THE MERCURY–ELECTROLYTE INTERFACE. PART I. INVESTIGATIONS ON SOME ORGANIC COMPLEXING AGENTS FOR THEIR SUITABILITY AS FILM-FORMING SUBSTANCES FOR ENRICHMENT STUDIES IN INORGANIC DEPOLARIZERS. Berge, H.; Ringstorff, H. (Univ., Rostock, Ger.). Anal. Chim. Acta; 55: No. 1, 193-9(Jun 1971). (In German).

Tributyl phosphate (TBP), tripropyl phosphate (TPP), titan yellow, phenylarsonic acid, o- and p-aminophenylarsonic acid, 8-hydroxyquinoline, oxine-5-sulfonic acid, thioxine, tetraethylammoniumdithiocarbamate, rhodamine B, and magneson II were studied for their suitability for the concentration of metal traces in the adsorption layer of these reagents on a mercury surface. Only TBP and TPP were suitable. Tests were made with MoO_2^{2-}, ZrO^{2+}, UO_2^{2+}, VO_3^-, WO_4^{2-}, Pb^{2+}, and Tl^+; only uranyl and tungstate ions could be accumulated in the presence of TBP and TPP. (auth)

48581 ACIDIC ORGANODIPHOSPHORUS EXTRACTANTS. EXTRACTION OF EUROPIUM(III) BY A DIPHOSPHONIC ACID IN DIFFERENT ORGANIC SOLVENTS. Jamil, M.; Zur Nedden, P.; Duyckaerts, G. (Univ., Liege). Anal. Chim. Acta; 55: No. 1, 145-51(Jun 1971).

The distribution of di-n-butyl- ethane-(1,2)-diphosphonic acid (H_2B_2EDP) between 1 M (H, Na)ClO_4 and benzene or methyl isobutyl ketone has been studied radiometrically. The partition constants of H_2B_2EDP are calculated. The results indicate than H_2B_2EDP remains monomeric in benzene up to a total concentration of $1.3 \cdot 10^{-2}$ M, while it is monomeric throughout the whole concentration range up to saturation in methyl isobutyl ketone. Europium is extracted from an aqueous phase 1 M (H, Na)ClO_4 by H_2B_2EDP into benzene, $CHCl_3$, $CHBr_3$, methyl isobutyl ketone and into benzene containing 12% pentanol-1. The extraction data indicate that europium is extracted into benzene as $Eu(AH)_3AH_2$, while the stoichiometry of the complexes extracted into methyl isobutyl ketone and into benzene containing 12% pentanol-1 seems to be $EuA(AH) \cdot xRR'C=O$ and $Eu(AH)_3 \cdot xROH$, respectively. On the assumption that during the extraction of europium(III) the extractant also remains a monomer in $CHCl_3$ and $CHBr_3$ in the concentration range studied, it is concluded that the formula of the europium complex extracted is $Eu(AH)_3AH_2$. (auth)

48582 ANALYTICAL STUDIES ON THE HAFNIUM–SCANDIUM SEPARATION ON ANION-EXCHANGE RESINS. Balsenc, Lucette; Beeler, R.; Haerdi, W.; Monnier, D. (Univ., Geneva). Anal. Chim. Acta; 55: No. 1, 253-61(Jun 1971). (In French).

The distribution of hafnium(IV) and scandium(III) sulfate complexes between an anion exchange resin in the sulfate form, and sulfuric acid solutions has been studied. Equations giving the variation of the distribution ratio with the ligand concentration have been established for both metals; the sulfate complexes formed in solution are discussed. For hafnium, the optimal conditions for adsorption involve sulfate concentrations of 2×10^{-2} to 10^{-1} M at

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pH 3.5 to 4.5; for elution 2 to 4 N sulfuric acid should be used. For scandium, optimal adsorption is obtained with 10^{-1} M sulfate at pH 3, and ≥0.4 N sulfuric acid is best for elution. (auth)

48583 PROCESSES FOR IMPROVED FISSION PRODUCT SEPARATION IN THE REPROCESSING OF HIGHLY BURNT UP THORIUM-CONTAINING NUCLEAR FUELS. Kuechler, Leopold; Schaefer, Lothar; Wojtech, Bernhard (Farbwerke Hoechst AG, Frankfurt am Main). Chem.-Ing.-Tech.; 43: No. 10, 601-4(May 1971). (In German).

The reprocessing of thorium-containing nuclear fuels by the acidic Thorex process with acidic feed solution has the advantage that formation of hydrolysis precipitates is avoided on adjustment of the fuel solution for extraction, although low decontamination factors are obtained for the recovered thorium. Adequate decontamination can be achieved by addition of ethylenediaminetetraacetic acid to the washing liquid in the extraction battery. (auth)

48584 IONNYI OBMEN V RADIOKHIMII. (Ion Exchange in Radiochemistry). Egorov, E. V.; Makarova, S. B. Moscow; Atomizdat (1971). 408p.

This monograph summarizes the applications of ion exchange techniques to the chemistry and technology of radioisotopes. The problems connected with reprocessing irradiated nuclear fuels, the separation, concentration, and purification of nuclear fuels and fission products, and the rare earth and transuranium elements are considered. Information is presented on the use of ion exchange in the synthesis of artificial and the separation of natural radioactive isotopes. The use of ion exchange in analytical chemistry is explored, as well as the use of radioisotopes in investigating ion exchange phenomena. Sorption methods and ion exchange processes are described for the deactivation of waste water, and the purification of water for nuclear reactor use. The properties of ion exchange resins are examined, together with the effect on them of ionizing radiation. Two useful indexing lists are included: a list of the ion exchange materials and sorbents mentioned in the book, with pagination, and a list of elements and isotopes considered, with pagination. (2,051 references) (tr-auth)

48585 SOLVENT EXTRACTION PROCESS FOR SEPARATING GADOLINIUM FROM TERBIUM AND DYSPROSIUM. Chiola, Vincent; Kim, Tai K.; Long, Robert E. Jr.; Martin, Brooks C. (to Sylvania Electric Products Inc.). U. S. Patent 3,582,263. 1 Jun 1971. Filed 31 Oct 1969.

A process is described for the purification of Gd in which an aqueous solution containing Gd values and heavy rare earths, notably dysprosium and terbium, is contacted with an organic extraction solution consisting essentially of didecyl phosphoric acid, tributyl phosphate, and an aliphatic hydrocarbon solvent to remove an appreciable amount of the heavy rare earths into the organic phase without an appreciable removal of Gd from the aqueous phase. (Offic. Gaz.)

48586 THIN-LAYER CHROMATOGRAPHY IN INORGANIC ANALYSIS. COMMUNICATION 8. THE USE OF NEW MODIFIED SORBENTS FOR SEPARATING INORGANIC IONS. Volynets, M. P.; Egorov, E. V.; Myasoedova, G. V. (Inst. of Geochemistry and Analytical Chemistry, Moscow. All-Union Scientific-Research Inst. of Chemical Reagents and Specially Pure Chemicals, Moscow). Zh. Anal. Khim.; 26: No. 7, 1434-9(Jul 1971). (In Russian).

New modified sorbents, sulfurated silica gel and chelating celluloses, were used for separating inorganic ions by the thin-layer chromatography. Thin layers on the plates made of a mineral–organic ion exchanger are more stable (owing to small swelling in aqueous solutions) as compared with those on organic ion exchange resins. Under certain conditions modified celluloses permit the simultaneous concentration and selective detection of some elements which interact specifically with chelating groups introduced into cellulose. Examples are given of separating various combinations of elements (Se–Te, Te–Pt, Th–rare earths, Th–U, Zr–U, U–Se, U–Hg, Zr–Hg) and of the selective isolation and detection of Cu, Pd, Th, U, Nb, V, In, Ga, Al, and Zr on layers of modified celluloses. (auth)

48587 ION EXCHANGE IN THE PROCESS INDUSTRIES. Conference Held at London, 16th–18th July, 1969. London; Society of Chemical Industry (1970). 449p. £ 10. (CONF-690712).

Fifty-eight papers were presented under the following session titles: Preparation and properties of organic resins; developments in the design of ion exchange plant; developments in the design of ion exchange processes; separation and radioactive waste treatment; sugar processing by ion exchange; selected topics; developments in inorganic exchangers; and water and effluent treatment. Separate abstracts are given for nine of these papers. (UK)

For abstracts of individual papers see: 48509 and 48588–48595.

48588 GENERIC ION-EXCHANGE PROCESS FOR THE RECOVERY AND PURIFICATION OF VALUABLE ELEMENTS FROM THE NUCLEAR INDUSTRY. Wheelwright, E. J. (Battelle-Northwest, Richland, Wash.). pp 202-8 of Ion Exchange in the Process Industries. London; Society of Chemical Industry (1970).

From International conference on ion exchange in the process industries; London, England (16 Jul 1969). See CONF-690712.

The versatility of a shielded ion exchange facility operated as an adjunct to a reactor fuel reprocessing plant is discussed. The feasibility and economic advantage of using such a processing facility for recovery and purification of a large number of valuable elements are pointed out, and several separation flowsheets are briefly reviewed, including separation and purification of fission products Sr, Pm, Am, Cm, Cs, Tc, Rh, Pd, Pu, and Np. (auth) (UK)

48589 ION EXCHANGE PROPERTIES OF ZIRCONIUM AND TITANIUM PHOSPHATES AND THEIR USE IN THE SEPARATION OF NUCLEAR REACTION PRODUCTS. Baetsle, L. H.; Markl-Musyl, I.; Huys, D. (SCK-CEN, Mol, Belgium). pp 209-15 of Ion Exchange in the Process Industries. London; Society of Chemical Industry (1970).

From International conference on ion exchange in the process industries; London, England (16 Jul 1969). See CONF-690712.

Mixtures of ^{227}Ac, ^{228}Th, and ^{226}Ra in nitric acid solution were separated by passing through a zirconium phosphate column followed by a titanium phosphate column. The mechanism of ion exchange was investigated. Distribution coefficients of various ions were found as a function of molarity of the nitric acid solution, and an explanation of the observed selectivity is given. A study of the ion exchange adsorption of the Th(IV) ion showed it to be adsorbed as a complex species. (auth) (UK)

48590 ION-EXCHANGE PROPERTIES OF A VOLCANIC TUFF AND ITS APPLICATION TO SELECTIVE ADSORPTION OF RADIONUCLIDES. Lutze, W.; Levi, H. W. (Hahn-Meitner-Institut, Berlin). pp 216-23 of Ion Exchange in the Process Industries. London; Society of Chemical Industry (1970).

From International conference on ion exchange in the process industries; London, England (16 Jul 1969). See CONF-690712.

The ion exchange properties of a volcanic tuff occurring in Germany were investigated. The material is commercially available under the name "Filtrolit" and it was formerly applied to water softening and filtration. The mineralogical composition is briefly discussed. Isotopic and ion exchange experiments were performed, and apparent self-diffusion coefficients were calculated. Both batch tests and column tests have been carried out on a laboratory scale in order to evaluate the suitability of the tuff for decontamination of radioactive effluents, and application to hard tap waters containing radioactive Cs, Sr, Ba, and Ce, respectively, have so far been investigated. The construction of a pilot plant for decontamination experiments on a semi-technical scale is described, and the results obtained from several runs under various conditions are discussed. (auth) (UK)

48591 COMPARISON OF ION-EXCHANGE PROPERTIES OF AMORPHOUS AND CRYSTALLINE INSOLUBLE ACID SALTS OF TETRAVALENT METALS AND POLYBASIC ACIDS. Alberti, G.; Allulli, S.; Costantino, U.; Massucci, M. A.; Torracca, E. (CNEN, Rome. Univ., Rome). pp 318-21 of Ion Exchange in the Process Industries. London; Society of Chemical Industry (1970).

From International conference on ion exchange in the process industries; London, England (16 Jul 1969). See CONF-690712.

Advantages and disadvantages of amorphous and crystalline exchangers are reported and discussed. Crystalline materials, besides having a more definite composition, compare favorably with the corresponding amorphous materials as regards thermal degradation and stability towards hydrolysis. Moreover, several crystalline exchangers can exhibit good ion sieve properties and therefore they can be employed to carry out very good separations of inorganic ions of different crystalline radius. However, ion exchange studies with crystalline materials are often complicated by the formation of new crystalline phases and by hysteresis phenomena, and therefore amorphous exchangers can be preferred for some uses. Amongst crystalline materials considered were the phosphates and arsenates of Ti, Zr, Ce, Th, Sn, and Pb. (auth) (UK)

48592 PROPERTIES OF HYDROUS OXIDE INORGANIC EXCHANGERS. Pai, K. R.; Krishnaswamy, N.; Datar, D. S. (Central Salt and Marine Chemicals Research Inst., Bhavnagar, India). pp 322-8 of Ion Exchange in the Process Industries. London; Society of Chemical Industry (1970).

From International conference on ion exchange in the process industries; London, England (16 Jul 1969). See CONF-690712.

Hydrous oxides of thorium, zirconium and aluminum were prepared using sodium hydroxide and ammonia in different metal to alkali ratios (only one stable hydrous aluminum oxide was prepared and studied). The anion exchange and cation exchange capacities were determined by measuring the chloride displaced from the exchanger by nitrate ion and by calcium uptake, respectively. With increasing metal to alkali ratio and ammonium hydroxide for precipitation hydrous thorium oxide showed decreasing anion exchange capacity and increasing cation exchange capacity, and hydrous zirconium oxide showed increasing cation exchange capacity. With sodium hydroxide, for hydrous thorium oxide both cation and anion exchange capacities remained independent of the amount used, but for hydrous zirconium oxide cation exchange capacity increased with the alkali added. The hydrous oxides of thorium and zirconium precipitated with sodium hydroxide had greater porosity and showed faster rates of exchange than those precipitated with ammonium hydroxide. The pH titration curves for thorium and zirconium hydrous oxides indicated the presence of only one active group. (auth) (UK)

48593 ION-EXCHANGE PROPERTIES OF THE SYNTHETIC ZEOLITE, LINDE T. Sherry, H. S. (Mobil Research and Development Corp., Princeton, N. J.). pp 329-38 of Ion Exchange in the Process Industries. London; Society of Chemical Industry (1970).

From International conference on ion exchange in the process industries; London, England (16 Jul 1969). See CONF-690712.

A sample of the synthetic zeolite Linde T was prepared according to the procedure outlined in the Union Carbide patent. Attempts to replace all the K^+ ions from the pure K form of this zeolite indicate that 25% of the total cations, or one out of the four cations in a unit cell, are not exchangeable below 300° in dilute aqueous salt solutions. Structural considerations make it likely that the non-exchangeable K^+ ion in each unit cell is in the small cancrinite cage. Univalent ion and alkaline earth ion exchange equilibria were studied at 25°. The data are presented in the form of ion exchange isotherms and selectivity coefficient plots. The free energy of exchange was computed from the selectivity data for all the reactions studied. The univalent ions are preferred in the decreasing order $Cs > Rb > Ag > K \geq NH_4 > Na > Li$, with large separation factors between adjacent alkali metal ions. The study of alkaline earth–alkali metal ion exchange reactions revealed that this zeolite prefers K^+ to Ba^{2+} and Ca^{2+} ions. This behavior was predicted by a simple theory of ion specificity. (auth) (UK)

48594 CATION DIFFUSION KINETICS IN SYNTHETIC ZEOLITES OF TYPES X AND A. Hoinkis, E.; Levi, H. W. (Hahn-Meitner-Institut, Berlin). pp 339-51 of Ion Exchange in the Process Industries. London; Society of Chemical Industry (1970).

From International conference on ion exchange in the process industries; London, England (16 Jul 1969). See CONF-690712.

Self-diffusion of alkaline earth ions in zeolite X and of alkaline earth and alkali metal ions in zeolite A was studied. Methods were developed to measure fast exchange processes with aqueous solutions even at temperatures above 100°. The heterogeneous diffusion processes observed were split into two independent diffusion processes. For zeolite X a model can be given which explains this behavior. Some effects of self-diffusion kinetics on the ion exchange behavior are demonstrated and discussed. (auth) (UK)

48595 SELF-DIFFUSION AND EXCHANGE DIFFUSION OF CATIONS IN VERMICULITE. Miekeley, N.; Levi, H. W. (Hahn-Meitner Inst., Berlin). pp 362-8 of Ion Exchange in the Process Industries. London; Society of Chemical Industry (1970).

From International conference on ion exchange in the process industries; London, England (16 Jul 1969). See CONF-690712.

Self-diffusion coefficients and activation enthalpies were determined for various cations in mono-ionic and bi-ionic vermiculites by means of heterogeneous isotopic exchange. The self-diffusion of Ba, Ca, Sr and La ions was found to be controlled only by the hydration of the cations, whereas the diffusion behavior of Na was essentially controlled by electrostatic forces between the Na ions and the fixed negative charge of the silicate surface. In bi-ionic Na/Sr- and Ba/Sr-vermiculites the self-diffusion coefficients depend upon the ionic composition of the exchanger. The influence of the variable self-diffusion coefficients on the kinetics of the ion exchange reactions Na/Sr^{2+} and Ba/Sr^{2+} and their reversals is discussed. (auth) (UK)

48596 CHEMICAL CONVERSIONS AND PHASE TRANSFORMATIONS IN URANIUM HEXAFLUORIDE AT HIGH TEMPERATURES. Galkin, N. P.; Tumanov, Yu. N. At. Energ. (USSR); 30: No. 4. 372-6(Apr 1971). (In Russian).

Following up previous studies on the equilibrium constants $(UF_6)_{gas} \rightleftharpoons (UF_4)_{gas} + 2(F)_{gas}$ reaction, the thermal dynamic and kinetic characteristics of the decomposition of gaseous UF_6 and the separation of UF_4 at about 3×10^3°K were studied. The work involved determination of the partial pressures in the mixture formed by the decomposition of UF_6. Examination of the temperature dependence curves of these partial pressures revealed that the partial pressure of UF_6 decreases sharply beyond 2200°K; the partial pressure of pentafluoride passes through a maximum of $T = 2.4 \times 10^3$°K and the tetrafluoride maximum lies at $T = 3.2 \times 10^3$°K. The complete conversion of the tetrafluoride requires heating up to 3200 to 3400°K. The structural changes were also identified, calculating the rate constants of the combination reaction. By cooling the high-temperature mixture of the fluorides suddenly, the penta and tetrafluorides may be condensed; Frenkel's formula allowed one to calculate the condensation rate. (TTT)

48597 ISOTOPE ENRICHMENT METHOD AND APPARATUS. (to Commissariat a l'Energie Atomique). British Patent 1,237,474. 30 Jun 1971. Priority date 1 Aug 1968, France.

A method and an apparatus for the photochemical enrichment of an isotope are given. They are applicable particularly to mercury. The isotope mixture and a reactive substance (which reacts with the excited isotope) are introduced into a reaction zone wherein the gaseous mixture is irradiated with monochromatic radiation (which excites only one of the isotopes). A stream of inert liquid is passed through the zone, whereby the compound formed by the excited isotope and the reactive substance is dissolved and removed from the zone. For the separation of Hg isotopes, the reactive substance is a combination of water or oxygen and butadiene, and the inert liquid may be water, ethylene glycol, and mixtures thereof. The monochromatic lamp is a Hg-vapor lamp, which emits 2537-Å radiation. The operation of the apparatus is continuous, leading to increased output. (D.L.C.)

48598 SEPARATION OF TRACE-METAL IONS FROM SEAWATER BY ADSORPTIVE COLLOID FLOTATION. Kim, Young S.; Zeitlin, Harry (Univ. of Hawaii, Honolulu). J. Chem. Soc., D; No. 13, 672(7 Jul 1971).

An adsorptive colloid flotation process based on a collector–surfactant–air system makes possible the rapid separation of various cationic including Zn and Cu and anionic including Mo and U metallic species from seawater. (auth) (UK)

XUM

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 48616, 48656, 48778, 48953, 49028, 49964, and 50615.

48599 (AEC-tr-7230) RADIOISOTOPE INVESTIGATIVE METHODS IN ENGINEERING GEOLOGY AND HYDROGEOLOGY. Ferronskii, V. I.; Danilin, A. I.; Dubinchuk, V. T.; Goncharov, V. S.; Polyakov, V. A.; Seletskii, Yu. B.; Flekser, N. Ya. Translation of Radioizotopnye Metody Issledovaniya v Inzhenernoi Geologii i Gidrogeologii, Atomizdat, Moscow, 1968. 254p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 37944.

48600 (ANL-7760(Pt.3), pp 1-17) THERMAL PLUME MEASUREMENTS. Romberg, Gerald P.; Prepejchal, William; Nelson, Donald M. (Argonne National Lab., Ill.).

In Radiological Physics Division annual report.

Numerous lake temperature surveys were made near the warm water discharge from a 1100 MW fossil fuel electric generating plant located on the west shore of Lake Michigan at Waukegan, Illinois. The measurements allowed the construction of isotherms to define the various temperature regions of the plume. Plume configurations ranged from north through south and both stable and upwelling lake conditions were encountered. The calculated size and heat content of the observed plumes varied by a factor of ten and generally tended to be smaller for upwelling conditions. Mean values for the distribution of heat content for all plumes analyzed to date showed that typically 60% of the heat content was in the upper 3 ft of water and over 70% was contained in water less than 3°C above ambient. Mean values for the distribution of plume volume contained water more than 5°C above ambient. (auth)

48601 (BNWL-SA-3744) RADIOLOGICAL IMPACT OF HANFORD WASTE DISPOSAL ON GROUNDWATER QUALITY. Essig, T. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest L b.). [1970]. Contract AT(45-1)-1830. 11p. (CONF-710710-2). Dep. NTIS.

From sixteenth annual Health Physics Society meeting; New York, N. Y. (12 Jul 1971).

Since the startup of the Hanford plant over 25 years ago, large volumes of liquids containing low concentrations of radioactivity have been discharged to ground disposal sites in the Chemical Separations Areas. These disposal sites are located on a plateau in the Hanford project interior, about 12 to 15 miles up-gradient from the nearest domestic water source. An extensive ground water surveillance program has been maintained since the startup of the Hanford plant. The ground water monitoring program is described and the impact of radioactive waste disposal on the ground water beneath the Hanford plant is shown. Gross beta activity (primarily $^{106}Ru-Rh$) concentrations in the ground water during the last five years are reviewed. It will be seen that in recent years, the geographical distribution of this activity has become fairly stationary and that after many years of discharging liquid effluents to ground, the gross beta activity concentrations are decreasing. (auth)

48602 (CONF-710402-(Vol.3), pp III.30-42) USE OF ^{252}Cf AS A NEUTRON SOURCE FOR WELL LOGGING. Paap, Hans J.; Scott, Hugh D. (Texaco, Inc., Bellaire, Tex. Bellaire Research Labs.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

A major goal of the well logging industry is the identification of potential oil producing horizons in the earth formations surrounding a borehole. Neutron logs are used to determine porosity, salinity, and the presence of gas. Improvements and new techniques possible with higher intensity ^{252}Cf neutron sources are discussed. (auth)

48603 (CONF-710402-(Vol.3), pp III.48-58) NEUTRON TECHNIQUES IN GROUND WATER EXPLORATION. Ferronsky, Vasilii I. (International Atomic Energy Agency, Vienna (Austria)).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

The interest of many countries in using ground water has especially risen during the last years, in line with the increased pollution of surface waters. An increased consumption of ground water for irrigation in arid countries can also be observed, and many types of brines are used for industrial purposes. Mineral waters are employed for balneological and therapeutical purposes, and thermal waters for development of energetics. The use of neutron sources for different kinds of neutron well logging and for exploration of aquifers and their properties under different geological conditions is described. Examples for the use of penetration neutron logging in the investigation of unsaturated and saturated zones in the upper layer of soils in arid and humid areas are given. Different aspects of neutron techniques to be applied in investigations of recharge of ground water through unsaturated zones for hydrogeological observations are presented. Some factors influencing the finding of an optimal network for observations of regime of moisture in unsaturated zones are described. Reference is made to different types of moisture gauges, with neutron sources which are used for these purposes. The activities of the IAEA to promote development of neutron methods in ground water exploration are also mentioned. (auth)

48604 (ORNL-TM-3502) SEISMIC MAPPING OF HYDRAULIC FRACTURES. McClain, W. C. (Oak Ridge National Lab., Tenn.). Aug 1971. Contract W-7405-eng-26. 32p. Dep. NTIS.

For the last 5 years, the Oak Ridge National Laboratory has been using an adaptation of the oil-field technique of hydraulic fracturing for the disposal of radioactive waste solutions into a shale formation at a depth of about 1000 ft. Information about the location, direction, extent, and attitude of the induced fractures is absolutely essential in waste disposal operations, both as a routine check on operational technique and, even more importantly, during testing to determine the suitability of a particular site. Based upon a recent test at Oak Ridge, it appears that the developing and propagating fracture advances in such a way as to generate a series of very low amplitude seismic signals—presumably due to tensional elastic rebound at the tip of the fracture. These signals can be detected on a network of highly sensitive seismometers and the records, after proper filtering, used to locate the focus of each event. Three-dimensional plotting of these focii then provides a map of the hydraulic fracture which can even be related to time in order to examine the manner of its development. The accuracy of location of the focus for each individual event appears to be of the order of plus or minus 100 ft and inherently limited by the seismic transmission properties of rock. However, a seismometer network, containing several redundant instruments and therefore permitting a number of independent locations for the same event, should provide a statistically much more accurate location. (auth)

48605 (TID-25729(Suppl.)) SUPPLEMENT TO THE ENVIRONMENTAL STATEMENT: RADIOACTIVE WASTE REPOSITORY, LYONS, KANSAS. (Atomic Energy Commission, Washington, D. C.). Jul 1971. 103p. Dep. NTIS.

An exchange of correspondence between Representative Joe Skubitz, 5th District Kansas and the Atomic Energy Commission is presented. (D.H.M.)

48606 (TID-25764) PRELIMINARY EVALUATION OF HYDROLOGIC FACTORS RELATED TO RADIOACTIVE WASTE STORAGE IN BASALTIC ROCKS AT THE HANFORD RESERVATION, WASHINGTON. La Sala, A. M. Jr.; Doty, G. C. (Geological Survey, Richland, Wash. Water Resources Div.). 1971. 72p. Dep. NTIS.

A preliminary study of the hydrologic factors related to the feasibility of storing high-level radioactive wastes in deeply buried basaltic rocks of the Hanford Reservation was begun with the drilling of a test well. The factors of concern include the rate and direction of groundwater movement, the characteristics of ground-water discharge, and the geochemical nature of the waste-rock-water system that might affect the movement of radionuclides. It was concluded that under the prevailing head relationships and assuming that the observed geohydrologic conditions are widespread, it may be feasible to store radioactive wastes that would decay to low levels in 600 to 1,000 years in mined cavities in thick impermeable rock layers below about 1,200 feet in depth. However, further studies will be necessary to define the characteristics of the ground-water system and to evaluate the conditions under which wastes could move through the system to the human environment. (D.H.M.)

48607 ABUNDANCE AND DISTRIBUTION OF URANIUM AND THORIUM IN THE SYENITE OF PIZ GIUV (AAR-MASSIF, SWITZERLAND). Labhart, T. P.; Rybach, L. (Univ., Bern. Eidgenoessische Technische Hochschule, Zurich). Chem. Geol.; 7: No. 4, 237-51(Jun 1971).

The elongated Giuv Syenite (Aar–Massif, Switzerland) contains remarkably high amounts of thorium and uranium. Mean values of 44 samples: 66.0 ppM Th, 22.1 ppM/U, Th/U = 3.19. U and Th have, despite the relatively small dimensions (6 × 0.5 km) of the syenite body, a zonal distribution: uranium concentrations increase from a core area with 15.0 ppM towards rim zones with 28.1 ppM, whereas the Th/U ratio decreases from 3.68 to 2.75. This zonal arrangement corresponds roughly to the distribution of rock types in the syenite (fine-grained rim facies, porphyritic central facies). The finer-grained variety has higher values (means of 11 samples: 78.7 ppM Th, 30.8 ppM U, Th/U = 2.74) than the porphyritic facies (means of 33 samples: 61.8 ppM Th, 19.2 ppM U, Th/U = 3.35). Potassium is more or less homogeneously distributed within the syenite mass (mean of 44 determinations: 4.9% K, width of variation: 3.5 to 5.7% K). Anomalously high U concentrations (up to 270 ppM) at shear zones are signs of postintrusive redistribution processes. (auth)

48608 STUDY OF THE CIRCULATION OF URANIUM IN THE SUPERGENE ENVIRONMENT IN THE ITALIAN ALPINE RANGE. Dall'Aglio, Mario (CNEN, Rome). Geochim. Cosmochim. Acta; 35: 47-59(Jan 1971).

Geochemical prospecting surveys for uranium, carried out in the metamorphic basement of the Italian Alpine Range, detected marked anomalies both in alluvia and waters in the Martello Valley (Trentino Region, Northern Italy). Detailed surveys showed that no uranium occurrences or deposits outcrop in the vicinity of the geochemical anomalies. A detailed study was therefore made in order to determine the causes of these anomalies. Analyses of uranium were made on fresh water, rock, stream sediment and soil samples. The water samples were also analyzed for all the major as well as for some trace elements. Leaching tests on rock samples provided additional information with a view to understanding better the dissolution of uranium with respect to the major elements. The results of these studies emphasize some characteristics of uranium in the supergene environment. Uranium, particularly that contained as uraninite in the pegmatites, is the element which passes most readily into the natural waters, where it may reach anomalous values, even starting from rocks with a normal content. Part of the uranium dissolved in fresh waters is precipitated by the organic matter of soils and stream sediments. The percentage of the uranium precipitated is not high, but it is sufficient to raise the uranium content of the alluvia to significant anomalous values. These processes, in the particular environment of the explored region, explain the anomalous values found in waters and alluvia, starting from rocks whose uranium contents average slightly more than the clarke value (~5 ppM). (auth) (UK)

48609 RADIUM, THORIUM, AND POTASSIUM DISTRIBUTION IN THE SEDIMENTS FROM THE CATALAN CONTINENTAL SHELF. Got, Henri (College Scientifique Univ., Perpignan, France). Compt. Rend., Ser. D; 272: No. 17, 2147-50(26 Apr 1971). (In French).

The core sample, 7 KR 70, which is characteristic of sedimentation in this zone indicates three levels at different depths. Level 1 is of the Flandrian period and level 3 of the Wurmian period. The sample also demonstrates the distribution of the various natural radioactive isotopes in the sediments. The Ra contents lie between 1 and 2×10^{-6} of the U equivalent; the Th content lies between 3 and 10×10^{-6}, and the K percentage between 1.4 and 2.2 per cent. (France)

48610 DIRECT MEASUREMENT METHOD OF RADIUM AND RADON CONTENTS IN NATURAL WATERS USING γ SPECTROMETRY. Bizollon, C. A.; Moret, R.; Molgatini, J. P. (Univ., Lyon). Ann. Phys. Biol. Med.; 5: No. 1, 45-63(1971). (In French).

A direct method for measuring the quantity of radium and radon in waters from natural sources is described. The method was applied to several natural sources in the Massif Central and the Alps. The data obtained are compared with those given elsewhere. (auth) (France)

48611 STRUCTURE AND ORIGIN OF THE ORGANIC SOIL COVER OF AMCHITKA ISLAND, ALASKA. Everett, K. R. (Ohio State Univ., Columbus). Contract AT(26-1)-171. Bioscience; 21: No. 12, 618(15 Jun 1971).

From twenty-first annual AIBS meeting; Bloomington, Ind. (26 Aug 1970). See CONF-700843.

A description is given of the organic soil cover of topographically low areas, high areas, and better drain areas of Amchitka Island. The organic soils of Amchitka were studied for baseline data for the Milrow test. As predicted, the Milrow event caused little damage to the soil cover except for some slumping along over-steepened stream bands, ejection of water along fractures in Sapric peat, small turn slides, and rock falls along the sea cliffs of both coasts (one rock fall of major proportions occurred on the Bering sea coast on a naturally unstable headland), and several small-scale hydrostatic eruptions, one of which is clearly related to energy focus on a bedrock prominence below the peat blanket. Only two cases of sliding at the boundary between peat and mineral soil could be documented, and these on very steep slopes. In all, approximately 13,000 m^3 of material were displaced by the Milrow event. (P.C.H.)

48612 GROUND SHOCK AND WATER PRESSURES FROM MILROW. Merritt, Melvin L. (Sandia Labs., Albuquerque, N. Mex.). Bioscience; 21: No. 12, 696-700(15 Jun 1971).

From twenty-first annual AIBS meeting; Bloomington, Ind. (26 Aug 1970). See CONF-700843.

Overpressure and acceleration measurements pertinent to biological studies subsequent to Milrow underground explosion are given. The data differ somewhat from the preliminary data of Kirkwood (BMI-171-126) in that the pressures at the marine live boxes were lower and the accelerations at a few positions were higher. (auth)

48613 GAMMA-CONTINUUM AT THE AIR–LAND INTERFACE. Gold, Raymond (Argonne National Lab., Ill.). Health Phys.; 21: No. 1, 79-83(Jul 1971).

Compton recoil γ-ray spectroscopy was used to measure the energy distribution of environmental γ radiation at the air–land interface. Observations showed a continuum varying slowly with energy in the region 0.22 to 2.1 MeV. A number of distinct peaks were superimposed on this slowly varying continuum corresponding to γ-ray transitions in naturally occurring radioisotopes. The integral γ flux in the 0.22 to 2.1 MeV energy region was 1.9 ± 0.4 photons cm^{-2} sec^{-1} corresponding to a mean continuum intensity of 1.0 ± 0.2 photons cm^{-2} sec^{-1} MeV^{-1} at the Argonne National Laboratory site (53°N geomagnetic latitude). The physical dose rate due to γ radiation in the energy interval 0.22 to 2.1 MeV was 4.3 ± 0.9 μR/hr. (auth)

Meteorology

Refer also to abstracts 48532, 48680, 48681, and 48753.

48614 (AD-717281) FALLOUT SIMULANT DEVELOPMENT: LEACHING OF FISSION PRODUCTS FROM NEVADA FALLOUT AND PROPERTIES OF IODINE-TAGGED SIMULANT. Final Report. Lane, William B. (Stanford Research Inst., Menlo Park, Calif.). Jun 1970. Contract DAHC20-69-C-0181. 56p. NTIS.

Long term leaching studies were conducted with field samples collected at SMALL BOY, JOHNIE BOY, and SEDAN. Fallout from each of these nuclear events was leached by 0.1N HCl (to represent stomach acid) and distilled water. The leaching mechanism for the removal of eight year old fission products from SMALL BOY fallout by 0.1N NHl appears to be controlled by a sorption reaction for a few days, after which it is controlled by a diffusion process. Leaching of SMALL BOY fallout by 0.1N HCl removed 60 percent of the activity from large particles and 30 percent from small particles. Leaching by water removed only a few percent of the activity. Generally less than 10 percent of the activity was removed from JOHNIE BOY or SEDAN fallout by either 0.1N HCl or water. A method was developed for safe production of radioiodine tagged synthetic fallout with a wide range of soluble or available iodine. (auth) (USGRDR)

48615 (AEC-tr-7137) RADIOACTIVE-CONTAMINATION FORECASTING. Timofeev, B. N.; Nesytov, Yu. K. Translation of Prognozirovanie Radioaktivnogo Zarazheniya, Voennoe Izdatel'stvo Ministerstva Oborony SSSR, Moscow, 1969. 69p. (TT-70-50151; IPST-Cat.-5842). Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 21827.

48616 (ANL-7760(Pt.3)) RADIOLOGICAL PHYSICS DIVISION ANNUAL REPORT. Environmental Studies, July 1969–December 1970. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 269p. Dep. NTIS.

Twenty-seven articles are included; separate abstracts were prepared for five. Four articles on: a semiautomatic method of neutron activation analysis with application to environmental studies; thermal neutron activation analysis of purified biological membranes; tritium studies quantify water movement in an old field ecosystem; and transpiration measurement in pines using tritiated water as a tracer were previously included in NSA as 25: 31876, 37403, 41687, and 41688, respectively. The remaining 18 articles contain information on: the Great Lakes Research Program, meteorology and air pollution, and methods and techniques. (P.C.H.)

For abstracts of individual papers see: 48600, 48617, 48618, 49018, and 49171.

XUM

48617 (ANL–7760(Pt.3), pp 245-8) RECENT TRENDS IN RADIOACTIVE FALLOUT. Gustafson, P. F.; Nelson, D. M.; Brar, S. S.; Muniak, S. E. (Argonne National Lab., Ill.).

In Radiological Physics Division annual report.

Continuing measurements of gamma-emitting radionuclides in air, soil, and foodstuffs collected in the Chicago area form the basis for the study of the long-term behavior of radioactive fallout. Data are presented on the identification of the spring maximum in fallout deposition, assessment of the radiation dose due to short-lived gamma emitters, and the major contributors of dietary ^{137}Cs. (L.C.L.)

48618 (ANL–7760(Pt.3), pp 249-50) HIGH ALTITUDE RADIOACTIVITY MEASUREMENTS MADE FROM THE ARGONNE SITE. Gustafson, P. F.; Keener, R. B. (Argonne National Lab., Ill.).

In Radiological Physics Division annual report.

The radiosonde equipment used for measuring high-altitude radioactivity in the atmosphere near the Argonne National Laboratory is described, and the results of Oct. 1970 measurements to 28 km are presented. (L.C.L.)

48619 (BLG–446(Vol.1)) ATMOSPHERIC DILUTION FACTORS AND CALCULATION OF DOSES IN THE ENVIRONMENT OF SCK/CEN MOL FOR SHORT AND LONG DURATION STACK DISCHARGES. Bultynck, H.; Malet, L.; Sharma, L. N.; van der Parren, J. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Jun 1970. 90p. Dep. NTIS (U. S. Sales Only).

The practical knowledge acquired at the SCK/CEN Mol in the field of atmospheric diffusion by the study of the turbulent diffusion of effluents from a high continuous source in relation with the atmospheric stability is applied to the discharges of the Nuclear Establishment of Mol. Seven categories of atmospheric stability are adopted and a separate approach is proposed for the cases of fumigation. The loss of material in the plumes due to settling, dry deposition and washout by rain is considered and appropriate correction factors are adopted. A mathematical model is developed to treat the problem of contamination of the atmosphere and of the surface in the environment, in case of releases of long duration. The model leads to the construction of polar diagrams of integrated concentrations in the air or average deposition on the ground. The probability of occurrence of the atmospheric stability categories is determined making use of the meteorological observations during 1966, 1967, and 1968. Calculations of doses following a radioactive release into the atmosphere are made taking into account the possible paths of exposure. A comprehensive set of diagrams is given in a separate section in order to facilitate the determination of dilution factors. (auth)

48620 (BLG–446(Vol.2)) ATMOSPHERIC DILUTION FACTORS AND CALCULATION OF DOSES IN THE ENVIRONMENT OF SCK/CEN MOL FOR SHORT AND LONG DURATION STACK DISCHARGES. Bultynck, H.; Malet, L.; Sharma, L. N.; van der Parren, J. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). [nd]. 113p. Dep. NTIS (U. S. Sales Only).

Data tabulations are presented for atmospheric dilution factors and calculations of doses in SCK/CEN Mol environment for short and long duration stack discharges. (D.H.M.)

48621 (BNWL–1551(Vol.2)(Pt.1)) ANNUAL REPORT FOR 1970 TO THE USAEC DIVISION OF BIOLOGY AND MEDICINE. VOLUME II. PHYSICAL SCIENCES. PART 1. ATMOSPHERIC SCIENCES. Simpson, C. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1971. Contract AT(45-1)-1830. 178p. Dep. NTIS.

A separate abstract was prepared for each of the thirty-six sections presented. (D.H.M.)

For abstracts of individual sections see: 48622–48657.

48622 (BNWL–1551(Vol.2)(Pt.1), pp 3-8) AEROSOL PARTICLE SIZE DEPENDENCE OF THE RAINOUT RATE. Slinn, W. G. N. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

The concept is introduced that in-cloud scavenging of aerosol particles should be viewed as a multi-rate process. The two rates considered are: the rate of attachment of aerosol particles to cloud water and, secondly, the cloud water removal rate. Estimates of both are given and a qualitative plot is constructed, which indicates the dependence of the "rainout rate" on aerosol particle size. (auth)

48623 (BNWL–1551(Vol.2)(Pt.1), pp 9-11) STUDIES OF IN-CLOUD SCAVENGING RATES AND MECHANISMS USING SHORT-LIVED COSMOGENIC RADIONUCLIDES. Young, J. A.; Perkins, R. W.; Thomas, C. W.; Wogman, N. A.; Scott, B. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

Rainwater concentrations of the cosmogenic radionuclides ^{24}Na, ^{38}Cl, and ^{39}Cl and their production rates from argon were measured in studies of the rates and mechanisms of in-cloud processes such as raindrop nucleation and precipitation scavenging. (auth)

48624 (BNWL–1551(Vol.2)(Pt.1), pp 12-22) PRELIMINARY ANALYSIS OF COSMOGENIC RADIONUCLIDE SCAVENGING. Slinn, W. G. N. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

A preliminary analysis is presented of two microphysical processes that could be responsible for the precipitation scavenging of cosmogenic radionuclides. It is tentatively concluded that the dominant mechanism responsible for the in-cloud scavenging of ^{38}Cl in continental convective clouds may be Brownian diffusional coagulation of the radionuclides directly with the precipitation embryos, whereas for ^{24}Na in maritime stratus clouds it may be cloud droplet nucleation scavenging. An approximate, time dependent scavenging ratio (κ/χ) is derived and some qualitative comparisons are made with experimental results. However, it is suggested that more aerosol and cloud physics data are needed before quantitative predictions can be made. (auth)

48625 (BNWL–1551(Vol.2)(Pt.1), pp 23-6) CASE STUDY OF IN-CLOUD SCAVENGING OR DIRECT PICKUP OF COSMOGENIC RADIONUCLIDES BY CLOUD WATER OR ICE. Davis, W. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

A case study was carried out for the storm of February 6, 1970 over Oregon and Washington. Results from the case study were input into a model for in-cloud scavenging of cosmogenic radionuclides and compared with ground measurements of these radionuclides. The model results indicated an in-cloud scavenging coefficient of 10^{-4} sec^{-1} to 10^{-3} sec^{-1} for ^{24}Na, ^{38}Cl and ^{39}Cl. (auth)

48626 (BNWL–1551(Vol.2)(Pt.1), pp 26-30) TIME CONSTANTS FOR CLOUD SEEDING AND TRACER EXPERIMENTS. Slinn, W. G. N. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

Estimates are derived for some appropriate time constants for weather modification and cloud physics tracer experiments. Under the assumption that ice-nucleation proceeds via contact nucleation (rather than by reverse-sublimation) estimates are made for the recommended number densities of AgI particles that should be released and for the time intervals that should be allotted, to affect both precipitation augmentation and hail suppression. Similar estimates are given for cloud physics experiments which use tracers generated by pyrotechnic flares. (auth)

48627 (BNWL–1551(Vol.2)(Pt.1), pp 30-5) NUMERICAL MODEL TO DESCRIBE OROGRAPHIC PRECIPITATION IN THE PACIFIC NORTHWEST. Scott, B. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

A two-dimensional numerical model is being developed to describe the meteorological events occurring as moisture laden air is orographically lifted over the coastal mountain ranges. The basic equations defining cloud and precipitation formation are presently being included in the model. These equations are presented and discussed. (auth)

48628 (BNWL–1551(Vol.2)(Pt.1), pp 35-41) STOCHASTIC GROWTH OF A RAIN DROPLET. Slinn, W. G. N.; Gibbs, A. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

Two approaches are used in this theoretical analysis of the stochastic growth by a coalescence of a single, large cloud droplet (rain droplet) as it falls through cloud droplets whose sizes and spatial locations are specified statistically. In the first approach, moments are taken of a linearized, difference-kernel, coalescence equation. The first and second moments are used to predict the mean and variance of the statistical density function for the mass of the rain droplet. The results are compared with a recent numerical prediction. In the second approach, an appropriate Fokker–Planck equation is obtained. This equation is derived both from the linearized coalescence equation and from an elementary statistical model. An exact solution to the Fokker–Planck

equation is derived and plots of the evolution of the statistical density function for the mass of the rain droplet are presented. These results are compared with those based on a Gaussian distribution. (auth)

48629 (BNWL–1551(Vol.2)(Pt.1), pp 42-50) FINITE-DIFFERENCE APPROXIMATION FOR EQUATIONS DESCRIBING THE FORMATION OF CLOUD AND PRECIPITATION. Scott, B. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

A set of partial differential equations can be used to describe the formation and growth of cloud and precipitation. The complex spatial dependence of the coefficients in the equations makes an analytic solution intractable and requires that the solutions be obtained numerically. A finite-difference approximation of the general equations has been developed and used to compute solutions for trial cases where the analytic solutions were known. The numerical results are presented and compared with the analytic solutions. In general, the numerical approximations produced quite acceptable results. (auth)

48630 (BNWL–1551(Vol.2)(Pt.1), pp 51-62) INQUIRY INTO THE CAUSES OF THE VARIATIONS IN THE BOMB DEBRIS SCAVENGING RATIOS. Slinn, W. G. N. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

A preliminary survey is made of the variability of each of the terms in the expression for the precipitation scavenging concentration ratios: $\kappa/\chi = \epsilon/\omega$, where κ is the concentration of the pollutant in the precipitation at ground level; χ is its concentration in the region of the atmosphere where the debris enters the precipitation; ϵ is the fraction of the radioactivity which enters the cloud water, and ω is the condensed water content of the cloud. It is seen that the variability of χ and ω could account for some of the observed variations in the scavenging ratios but it appears that the major causes are the variations in ϵ and κ. In particular, it is suggested that variations in κ arise from different average cloud droplet radii. (auth)

48631 (BNWL–1551(Vol.2)(Pt.1), pp 63-7) WASHOUT OF SOLUBLE DYE PARTICLES. Dana, M. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

Washout experiments were conducted using soluble rhodamine B particles with aerodynamic equivalent diameters ranging from 1.2 to 11.2 microns. The resulting washout coefficients for the particles larger than 1.8 microns agreed well with theoretical estimates for impactive scavenging. The smaller particle experiments resulted in anomalously high washout coefficients, not immediately explainable in terms of operating conditions or scavenging mechanisms. (auth)

48632 (BNWL–1551(Vol.2)(Pt.1), pp 68-74) PROPERTIES OF PARTICLES, AIRBORNE UNDER SIMULATED CONDITIONS ACCOMPANYING ACCIDENTS IN NUCLEAR INSTALLATIONS. du Plessis, L. A.; Schwendiman, L. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

The efficiency of removal of airborne radioactive particles by scavenging processes and gravitational settling is determined by the size, shape, and chemical and physical properties of the aerosols. A literature review was made primarily for the benefit of scavenging studies to determine the nature of aerosols arising from various nuclear installations during postulated accidents. The results of this survey are presented. A conclusion is reached that sources and conditions are extremely variable and every incident must be treated in more detail to obtain a particle size spectrum. Particularly lacking are data on the nature of aerosols following escape from the structure in which the incident occurred. If scavenging data are to be used most effectively, much more must be known about the nature of aerosols from accidental releases. (auth)

48633 (BNWL–1551(Vol.2)(Pt.1), pp 75-81) NUMERICAL EXPLORATIONS OF WASHOUT OF AEROSOL PARTICLES. Slinn, W. G. N. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

A theoretical framework is constructed for the applications to safety analyses of below-cloud rain scavenging research results. Semiempirical expressions are presented for the collection efficiency, for the raindrop and particle size distributions, and for the washout rates. Sample calculations are presented to describe the potentials of the analysis. These examples model the simulated reduction in airborne radioactivity and the contamination of the precipitation, that would result from below-cloud rain scavenging. (auth)

48634 (BNWL–1551(Vol.2)(Pt.1), pp 82-4) PRECIPITATION SCAVENGING OF TRITIUM AND TRITIATED WATER. Hales, J. M.; Schwendiman, L. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

A method is being developed, based upon reversible gas-scavenging theory, to enable the estimation of rain-scavenging rates of tritium and tritiated water. This method will be applicable to problems involving scavenging in plumes as well as in the general atmosphere. (auth)

48635 (BNWL–1551(Vol.2)(Pt.1), pp 84-91) EFFECT OF WIND ON RAIN SCAVENGING. Slinn, W. G. N.; Scott, B. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

A preliminary theoretical evaluation is made of the effect of wind on rain scavenging. The theory is compared with a recent calculation by Berg on the influence of the mean wind on experiment R15 performed by Engelmann. In agreement with Berg's, the results show that even in this extreme case of variable mean wind experienced by the raindrops, the effect of reasonable variations of aerosol particle mass density is more important than the variations of the mean wind. It is proposed that the calculations be extended to study the influence of atmospheric turbulence on scavenging. (auth)

48636 (BNWL–1551(Vol.2)(Pt.1), pp 91-7) RAINDROP ELECTRIC CHARGE: CONTINUOUS VERSUS SHOWERY RAINFALL. Dana, M. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

Sensitive measurements of electric charges on Pacific Northwest coastal raindrops show that there exist significant differences in the characteristics of the charge distributions between rains of different synoptic types. The continuous rain (generally prefrontal) is always positively charged, with little time variation in the distribution parameters; but instability showers are apt to have net charges of either sign with frequent switching and greater magnitudes. (auth)

48637 (BNWL–1551(Vol.2)(Pt.1), pp 98-101) CALIBRATION OF AN ULTRASONIC NOZZLE FOR AEROSOL GENERATION. Dana, M. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

Particle size measurements were made of the aerosol output of an ultrasonic nozzle. Dispersal of a 1.0 g/l solution of rhodamine B in methanol resulted in dry particles with mass median diameter about 0.2 micron and geometric standard deviation of 1.8. For liquid flow rates from 77 to 275 ml/min, and at an air pressure of 80 lb/in.^{2}, this size was essentially constant. Lower operating pressures resulted in larger particles. The initial droplet diameter of about 2.5 microns represents a considerable improvement over previous generation methods. (auth)

48638 (BNWL–1551(Vol.2)(Pt.1), pp 102-5) ALTERNATIVE DERIVATION OF THE CONVECTIVE DIFFUSION EQUATION. Slinn, W. G. N. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

A new and more convincing derivation is given of the generalized Smoluchowski–Kramers equation from the Fokker–Planck equation describing the motion of Brownian particles in a nonequilibrium environment. A solution to the Fokker–Planck equation is sought in the form of a Chapman–Enskog expansion. The first moment of the first two terms in this asymptotic expansion is sufficient to obtain the Smoluchowski–Kramers equation. The new convective diffusion equation is found to be identical to the previously reported results obtained by extending Kramers' method. (auth)

48639 (BNWL–1551(Vol.2)(Pt.1), pp 108-12) COMPARISON OF MAXIMUM EXPOSURES AT GROUND LEVEL RESULTING FROM SIMULTANEOUS RELEASE OF TRACERS FROM ELEVA-

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TIONS OF 2 AND 26 METERS. Nickola, P. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

Atmospheric tracers were simultaneously released from elevations of 2 m and 26 m for periods ranging from 30 to 60 min. The seventeen dual releases took place during a variety of atmospheric stabilities. Ground-level field sampling took place between distances of 0.1 and 12.8 km from the source. After normalism to unit mass emitted, ratios of exposures resulting from the two levels of release were formed. The magnitude of these ratios was strongly related to atmospheric stability at distances relatively close to the sources, but the reduction of exposure due to the aloft release was minimal beyond 3 km for all stabilities encountered. (auth)

48640 (BNWL–1551(Vol.2)(Pt.1), pp 112-16) MEASUREMENTS OF THE MOVEMENT, CONCENTRATION, AND DIMENSIONS OF INSTANTANEOUSLY GENERATED PUFFS OF AN INERT GAS TRACER. Nickola, P. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

Data generated during eight field puff releases of ^{85}Kr were analyzed. Information specifying effective speed and height, magnitude of short-period concentration, magnitude of crosswind and downwind concentration integrations, and dimensions of the puffs was generated. Perhaps the most significant conclusion reached was that the effects of atmospheric stability on puff dimensions were best shown when dimensions were considered as a function of time rather than of distance from source. (auth)

48641 (BNWL–1551(Vol.2)(Pt.1), pp 117-20) ADVANCEMENTS IN CAPABILITIES OF THE HANFORD INERT GAS TRACER SYSTEM FOR FIELD DIFFUSION STUDIES. Nickola, P. W.; Ludwick, J. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

The Hanford prototype inert gas field diffusion tracer system was improved and the field grid was extended. Sampling previously included 64 field detectors that were arrayed to a maximum height of 21 m on 6 towers and to a distance of 800 m from the tracer release point. The revised array of 128 sensors extends to a height of 42 m on 10 towers and to a distance of 1600 m. Remotely activated protective covers on the field sensors replace the manually removable covers of the prototype system. A capability for continually recording concentration fluctuations in fine detail replaces the intermittent recording with less detail associated with the prototype system. (auth)

48642 (BNWL–1551(Vol.2)(Pt.1), pp 120-1) TECHNOLOGY DEVELOPMENT FOR DUAL ATMOSPHERIC TRACER STUDIES ON AN INSTRUMENTED METEOROLOGICAL GRID. Ludwick, J. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

A noble-gas-tracer grid system is described that is used on a real time basis for the measurement of transport and diffusion of ^{85}Kr released as a puff or continuous source out to a distance of 800 meters. Factors that must be considered in dispersing tracer radionuclides to the environment are reviewed. The development of dual tracer experiments is considered, including preparation of radioisotope sources and measurement of the concentration of the tracers. (D.H.M.)

48643 (BNWL–1551(Vol.2)(Pt.1), pp 122-6) REAL PLUME AND ITS RELATIONSHIP TO THE APPARENT PLUME. Ramsdell, J. V. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

The real plume and its relationship to the time integrated or apparent plume are discussed. The crosswind concentration in the real plume is shown to be asymptotically Gaussian. The variance of the crosswind concentration distribution of the apparent plume is shown to be equal to the sum of the crosswind concentration variance and the meander variance of the real plume. The relative contributions of the diffusion and meander of a real plume to the diffusion of an apparent plume are discussed. (auth)

48644 (BNWL–1551(Vol.2)(Pt.1), pp 126-8) COMPARISON OF 12-HOUR PROGNOSTIC ISOBARIC TRAJECTORIES WITH CALCULATED TRAJECTORIES FROM HANFORD, WASHINGTON FOR OCTOBER 1970. Davis, W. E.; Thorp, J. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

A comparison of isobaric trajectories, calculated versus prognostic, indicated a correlation of 0.78 for distance traveled in 12 hours. A similar comparison of calculated trajectories versus isobaric trajectories based on persistence gave a correlation of 0.92 for a 12-hour movement. However, the 12-hour azimuthal difference between trajectory end points showed the prognostic trajectory to be superior to the persistence trajectory in anticipating the direction traveled from Hanford. (auth)

48645 (BNWL–1551(Vol.2)(Pt.1), pp 129-30) RADIATIONAL COOLING OF AIR PARCELS FOLLOWING THE EFFLUENT OF PHOEBUS 1B EP-IV, FEBRUARY 24, 1967. Davis, W. E.; Scott, B. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

An updated radiational cooling model predicted diabatic results consistent with airplane measurements of plume height. The computer model produced diabatic cooling results which were in approximate agreement with results derived from previous hand calculations. (auth)

48646 (BNWL–1551(Vol.2)(Pt.1), pp 130-4) PROJECT BOMEX STUDIES OF ATMOSPHERIC AND OCEANIC MIXING AND AIR-SEA INTERCHANGE USING RADIOACTIVE TRACERS. Young, J. A.; Silker, W. B. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

The activities of cosmogenic ^{7}Be and several bomb-produced radionuclides were measured in air, seawater, and rain samples during the Barbados Oceanographic and Meteorological Experiment (BOMEX). The inventories of ^{7}Be and the other radionuclides in the sea varied by a factor of about 2.5 during BOMEX with most of the variation occurring in the top 30 meters. The rapid variations in concentration were probably caused by horizontal transport of water masses of different activities through the BOMEX array. Air filter samples collected on the Island of Barbados indicated that air concentration of ^{7}Be varied seasonally with maximum concentrations occurring around May and June and minimum concentrations occurring in November and December. (D.H.M.)

48647 (BNWL–1551(Vol.2)(Pt.1), pp 134-8) DEVELOPMENT OF A SYSTEM FOR PROCESSING DIGITAL TURBULENCE DATA OBSERVED DURING BOMEX AND TEST DATA RESULTS. Woodruff, R. K. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

Participation in the Barbados Oceanographic and Meteorological Experiment required the development of a digital data processing capability for the turbulence data collected. Hardware modifications have been accomplished and software developed to permit reading data on field tapes directly into a computer. Additional programs have been written to restore the continuity of the data series, scale and edit the data and determine gross statistics. Test results from data collected from Barbados are comparable with oceanic data collected elsewhere by other investigators. (auth)

48648 (BNWL–1551(Vol.2)(Pt.1), pp 138-42) MODELING OF WIND COMPONENT SPECTRA. Elderkin, C. E.; Powell, D. C.; Horst, T. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

Modeling of turbulence spectra in neutral conditions shows a linear scaling with height to at least 60 meters for the vertical component with the normalized frequency of the peak somewhat higher than previously reported. The longitudinal component spectra also scale proportional to height above a frequency of 0.01 hertz and exhibit a second, low frequency peak, which does not depend on height. The low frequency portion of the lateral component shows no consistent modeling characteristics. The inertial subrange was found above 7.5 meters in the normalized frequency range above a value of about one. The expected $-5/3$ power dependence on frequency and the $4/3$ ratio between either vertical or lateral component spectra and the longitudinal spectra are reasonably well demonstrated. The theoretical nondimensional form of the inertial subrange was closely followed when the generally accepted value of 0.146 for Kolmogoroff's constant and the

recently adjusted value of 0.35 for Von Karman's constant are used. (auth)

48649 (BNWL–1551(Vol.2)(Pt.1), pp 143-8) DIABATIC EFFECTS ON ATMOSPHERIC TURBULENCE SPECTRA. Elderkin, C. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

The turbulence spectrum for the vertical velocity component in diabatic conditions is shifted in frequency from the spectrum for the neutral case. The data for unstable conditions are shifted to lower frequencies and the data for stable conditions to higher frequencies. When stability is included in the scaling of the non-dimensional frequency, as predicted in the inertial subrange by Kolmogoroff's expression with the dissipation determined through the turbulent energy budget equation, the spectra are all reasonably coincident and agreement with the inertial subrange theory was generally within 10%. This was accomplished by assuming that convective production equals the flux divergence of turbulent energy. The assumption that the flux divergence is zero, used in earlier spectral modeling work, does not organize the data so well. In addition, direct evaluation of the flux divergence demonstrates that it was definitely nonzero. However, it also does not precisely balance the convective production and appears to lag in its adjustment from one stability condition to another. (auth)

48650 (BNWL–1551(Vol.2)(Pt.1), pp 148-53) DIABATIC EFFECTS ON PROFILES OF THE SHEAR STRESS. Powell, D. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

Analysis of two periods of unstable data show the Reynolds stress correlation, $-\overline{u'w'}$, to vary markedly with height across the layer commonly designated as the constant flux layer for the neutral case. Vertical similarity is exhibited when the profiles are plotted versus z/L. By deleting Von Karman's constant from L, a new length, $L_* = kL$, was defined because L_* seemed to be a better measure of the approximate height at which the transition from mechanical turbulence to convective turbulence takes place. Since none of the terms in the standard equation of mean motion were found to be of sufficient magnitude to balance the observed decrease of height of the Reynolds stress, the inclusion of large order advective correlations, in particular, $w\partial U/\partial z$ is proposed. In the layer immediately adjacent to the surface roughness elements where the Reynolds stress was observed to increase with height, the distinction between the mean flow and the turbulence deteriorates. Therefore, the applicability of the equation to this type of turbulence is questioned. (auth)

48651 (BNWL–1551(Vol.2)(Pt.1), pp 154-6) NEW EXPRESSION FOR THE LOGARITHMIC WIND LAW. Powell, D. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

The logarithmic wind profile law is the physical result of interactions between the mean flow, characterized by $\overline{U}$, and the turbulence, characterized by u*. Although this is mathematically expressed by the logarithmic wind equation, from a physical point of view the equation is somewhat unsatisfying because none of the terms in it are of a form appropriate to express the physical interaction. Seemingly this can be remedied if Von Karman's constant is physically regarded as a function of $\overline{U}$ and u*. Such a function is proposed and presented although analytical justification of the idea has not been completed. (auth)

48652 (BNWL–1551(Vol.2)(Pt.1), pp 158-60) DEPOSITION VELOCITIES. Sehmel, G. A.; Schwendiman, L. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

Deposition velocities of monodispersed particles were measured for deposition onto a 0.7 cm high plastic grass surface and a smooth electrically grounded brass surface. These deposition velocities range from 0.06 to 12 cm/sec and show a rapid increase with particle diameter. The velocities are a function of the type of deposition surface as well as particle diameter (2 to 28 μm) and friction velocity (11 to 144 cm/sec). The average air velocity does not correlate the deposition velocities, but as a first approximation the deposition velocities are correlated by the friction velocity. (auth)

48653 (BNWL–1551(Vol.2)(Pt.1), pp 161-4) PARTICLE EDDY DIFFUSIVITIES. Sehmel, G. A.; Schwendiman, L. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

Particle effective eddy diffusion coefficients, ϵ/ν, [(Inertial + diffusion)/viscous forces], were calculated from experimental deposition fluxes to a smooth horizontal surface. The ϵ/ν values are a function of both particle inertia (τ^+), the distance from the surface (y^+), and the air friction velocity (u_*) which is contained in both dimensionless terms. These ϵ/ν values are greater than those for particle deposition along a vertical surface. Deposition velocities predicted from the correlation show minima of 1.8×10^{-4} to 7.7×10^{-3} cm/sec for particle sizes from 0.066 to 0.54 μm. The minima as well as all deposition velocities are equal to or much greater than predicted from gravitational settling. (auth)

48654 (BNWL–1551(Vol.2)(Pt.1), pp 166-7) PRECIPITATION PATTERNS ON THE ALE RESERVE. Hinds, W. T.; Thorp, J. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

A study of the pattern of total rainfall and snowfall on the Arid Lands Ecology (ALE) Reserve shows that precipitation is strongly influenced by the crosswind obstruction of Rattlesnake Hills, leading to a pronounced maximum in total precipitation below the crest. (D.H.M.)

48655 (BNWL–1551(Vol.2)(Pt.1), pp 168-9) PRECIPITATION ON THE ALE RESERVE FROM A SUMMER THUNDERSTORM SERIES. Thorp, J. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

Results of a study of precipitation distribution from thunderstorms on the Arid Lands Ecology (ALE) Reserve show that though 5% or more of the total annual precipitation falls in a single thundershower, wetted areas are so limited, evaporation rates are so great, and showery periods so infrequent during the summer months that available soil moisture from such showers can remain only a few days. Thus, it is doubtful that plants on the ALE reserve can make significant use of precipitation from summer thundershowers. (D.H.M.)

48656 (BNWL–1551(Vol.2)(Pt.1), pp 170-1) EVAPORATION FROM BARE AND VEGETATED LYSIMETERS AT DIFFERENT ELEVATIONS. Hinds, W. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

Small weighing lysimeters were placed in two old fields, at elevations of 600 and 1700 ft. At each elevation 33 lysimeters were installed: 21 planted to cheatgrass and 12 bare. At the 1700 ft elevation, more moisture was lost from bare soils than at the 600 ft elevation; but, for most of the spring growing season, a higher rate of transpiration was observed at 600 ft than at 1700 ft, indicating that the lower elevation provided a more efficient environment for moisture usage by cheatgrass than the higher elevation, partially off-setting the advantages of the high precipitation totals measured at the higher elevations. (D.H.M.)

48657 (BNWL–1551(Vol.2)(Pt.1), pp 171) CLIMATOLOGICAL INSTRUMENTATION ON THE ALE RESERVE, 1970. Thorp, J. M.; Hinds, W. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In annual report for 1970 to the USAEC Division of Biology and Medicine.

Two-point soil thermographs and strip chart hygrothermographs are now in operation at 600 feet, 1600 feet, 2900 feet and 3400 feet (all heights MSL). Propane-heated recording precipitation gages have been placed at the eastern and western extremities of a drainage basin. Other propane gages are at 660 feet and 3400 feet. A standard Weather Bureau type precipitation gage has been placed at 2900 feet. Two portable anemometers with recorders and a portable short wave pyranometer are available for short term micrometeorological and microclimatological investigations. (auth)

48658 (CLOR–83/D) CALCULATION OF THE RELATIVE CONCENTRATION OF THE RADIOACTIVE PARTICLES FALLING ON THE EARTH SURFACE. Kownacka, Ludwika (Centralne Laboratorium Ochrony Radiologiczne], Warsaw (Poland)). 1971. 24p. Dep. NTIS (U. S. Sales Only).

The theoretical prediction of relative concentration of heavy particles falling on to the earth's surface from a nuclear explosion cloud is explored. The calculations were based upon a simple linear model of radioactive cloud whose size and maximum height in the atmosphere is a function of explosion yield. Particle size-distribution in the cloud was determined by the log-normal function, and their fallrates were calculated by various methods depending on their respective size. The particle size distribution on the ground as the function of the distance from the source was calculated by

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assuming the wind velocity is a linear function of the height. Six equations were obtained for determining the relative concentration of the particles on the earth's surface. A GIER computer was used for the numerical calculations for the low yield explosions that produced clouds in the trophosphere and for the distances covered by the local fallout. Curves of the size-distribution of the particles for several distances and explosion yield are presented. Significant differences in the particle size distribution for different explosion yields were found. (auth)

48659 (FRNC-TH-40) RADON AND AEROSOL DIFFUSION IN THE TROPOSPHERE. Birot, Andre (Toulouse Univ. (France)). 1971. 169p. (In French). Dep. NTIS (U. S. Sales Only).
Thesis.

The way in which the naturally radioactive gas, radon, is used to study atmospheric physics, in particular, tropospheric exchanges, is discussed. Two complementary approaches to the problem are considered: a theoretical analysis of models based upon a numerical solution of the classical diffusion equation and in situ experimental work. Models corresponding to diverse conditions are presented e.g., geometry of the source and diffusivity and vertical wind profiles. (auth) (France)

48660 (IITRI-C-6105-14) SCAVENGING STUDY OF SNOW AND ICE CRYSTALS. Final Report. Sood, Sudesh K. (IIT Research Inst., Chicago, Ill.). 10 Feb 1971. Contract AT(11-1)-578. 72p. Dep. NTIS.

Scavenging efficiency of naturally precipitating snow and ice crystals was determined for submicron polystyrene latex and sodium chloride aerosols. The effect of crystal habit, dimensions, and particle size on scavenging efficiency was established. Experimental results show the scavenging efficiency to be a function of both the crystal and particle diameter. In addition, data on SO_2 scavenging by snow and ice crystals is also included. Experimental work on capture of aerosol particles by growing ice crystals was also initiated. Experimental data obtained so far show that the number of particles captured by a growing ice crystal is proportional to the mass of the crystal. (auth)

48661 (IITRI-C-6105-16) SCAVENGING STUDY OF SNOW AND ICE CRYSTALS. Quarterly Progress Report, May 1, 1971–July 31, 1971. Sood, Sudesh K. (IIT Research Inst., Chicago, Ill.). Aug 1971. Contract AT(11-1)-578. 24p. Dep. NTIS.

Experimental work on aerosol generation was resumed during this report period. A vaporization-condensation aerosol generator has been assembled and a number of fluorescent materials have been examined to determine the feasibility of using fluorescent aerosols during snow scavenging experiments. (auth)

48662 (LCA/MS-RAE-3/641) EXPERIMENTS IN CORRELATING THE RADIOACTIVITY OF THE AIR AND PRECIPITATIONS AT GROUND LEVEL WITH VARIOUS METEOROLOGICAL PARAMETERS. Kientzel, J. M.; Cambon, P. (Laboratoire Central de l'Armement, Arcueil (France)). Jan 1971. 67p. (In French). Dep. NTIS (U. S. Sales Only).

Radioactivity measurements taken over a three year period in the Paris area are considered. The experiments demonstrate the influence of certain factors, such as the origin of the air masses, the nature of the cloud layers, and the frequency of precipitation. No correlation between the results obtained and the height of the tropopause was found. (auth) (France)

48663 (SRO-344-12) WEST VALLEY REPROCESSING PLANT. PART I. Quarterly Report, January 1, 1971–March 31, 1971. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 20 Apr 1971. 8p. Dep. NTIS.

During the report period, three analyses were performed on milk from the NFS farm. The ^{131}I concentrations determined in the milk were all below 5×10^{-9} μCi/ml. Thirty-five samples were obtained from the perimeter monitoring stations and analyzed for alpha and beta activity. The alpha activities were all below 1.15×10^{-14} μCi/cc. The beta activity ranged from 5.49×10^{-15} μCi/ml to 7.09×10^{-13} μCi/ml with an overall average of 3.13×10^{-13} μCi/ml. The amounts of radioactivity discharged from the plant lagoons during this period and their relationship to the maximum permissible concentration (MPC) in the Cattaraugus Creek are tabulated. Effluent data not previously available are also presented. The amount of particulate radioactivity discharged via the plant stack and relationships of ^{85}Kr and ^{131}I to their release limits in technical specifications are shown tabularly. Data are also included on surveillance of facilities and equipment including filters. (J.R.D.)

48664 (UCRL-73270) PRODUCTION OF TRITIUM BY NUCLEAR WEAPONS. Miskel, John A. (California Univ., Livermore. Lawrence Radiation Lab.). 30 Jun 1971. 12p. (CONF-710809-3). Dep. NTIS.
From Tritium symposium; Las Vegas, Nev. (30 Aug 1971).

The effects of nuclear weapons tests on the current world tritium inventory can be summarized as follows: the contribution from fission weapons is negligible, whether they were tested in the atmosphere or underground; the contribution from the thermonuclear tests that were conducted in the atmosphere is large. The present inventory is approximately 45 times the natural background as a result of weapons testing and, even in the absence of further atmospheric tests, will be a significant (>10%) perturbation on the natural background for about 100 yr; and the underground testing of thermonuclear weapons has not contributed significantly to the atmospheric burden, even when the containment has been imperfect. (auth)

48665 (WASH-1183) SUMMARY INFORMATION ON ACCIDENTAL RELEASES OF RADIOACTIVE EFFLUENT TO THE ATMOSPHERE FROM UNDERGROUND NUCLEAR DETONATIONS DESIGNED FOR CONTAINMENT, AUGUST 5, 1963–JUNE 30, 1971. Allen, Robert E. (Division of Operational Safety (AEC), Washington, D. C.). Jun 1971. 28p. GPO $0.35.

Information concerning the 17 nuclear tests that inadvertently released sufficient radioactivity to the atmosphere to be detected by ground monitors or ground monitoring equipment off the testing site is presented, including depth of burial; quantity of radioactivity released to the atmosphere; types of radionuclides identified in the release; the highest air concentrations detected in the offsite area; the highest gamma exposure levels detected in the offsite area; the highest levels of radioiodine detected in milk; and the thyroid dose where sufficient radioiodine was detected that could lead to a measurable thyroid dose. (D.H.M.)

48666 PHYSICAL CLIMATOLOGY OF AMCHITKA ISLAND, ALASKA. Armstrong, Robert H. (Environmental Science Services Administration, Las Vegas, Nev.). Contract SF-54-351. Bioscience; 21: No. 12, 607-9(15 Jun 1971).
From twenty-first annual AIBS meeting; Bloomington, Ind. (26 Aug 1970). See CONF-700843.

Climatological statistics based on data from the vicinity of the airfield at the low-level southeast end of the island are presented. However, these statistics only approximate conditions for the relatively mountainous areas of the island. (P.C.H.)

48667 $^{12}C/^{13}C$ RATIO AS AN INDICATOR OF AIR POLLUTION. Atkins, Patrick R. (Univ. of Texas, Austin). Isotop. Radiat. Technol.; 8: No. 4, 381-5(Summer 1971).

The stable isotopes of several atmospheric constituents possibly can be used as natural tracers of pollutants and as indicators of general levels of pollution. A recent preliminary study is described in which CO_2 samples were collected by freeze-out and precipitation procedures and the $^{12}C/^{13}C$ ratios of the samples were determined. The results indicate that the $^{12}C/^{13}C$ ratio in atmospheric CO_2 can provide useful information about the degree—and perhaps the sources—of pollution that affects a given area. Freeze-out sampling is less convenient but more reliable, and probably more accurate, than precipitation. With some technique development and with calibration against freeze-out results, the precipitation procedure may prove to be usable. (auth)

Mineralogy and Exploration

48668 (JUL-755-PA-RG) URANIUM: SUPPLY AND DEMAND. ANALYSIS AND PROGNOSIS. Dietrich, Guenther; Schwarz, Helmuth; Voss, Alfred (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Apr 1971. 36p. (In German). Dep. NTIS (U. S. Sales Only).

Present world reserves of uranium, their exploration, and special aspects in regard to supply for West Germany are discussed. The most important uranium deposits are discussed as well as possibilities of their enlargement through prospecting. Growth of ore processing capacity is outlined. Based on the projected use of uranium, the theoretical point of exhaustion is calculated. For West Germany, nuclear energy applications are projected with respect to both power production and process heat. It is concluded that reduction of known uranium reserves encourages prospecting through which, thus far, new deposits were discovered. Therefore, limitation of uranium supply should not present a serious concern. (H.B.G.)

48669 URANIUM CONTENT AND ABUNDANCE IN DEEP-ZONE ROCKS OF THE EARTH CRUST AND UPPER MANTLE. Berzina, I. G.; Lutts, B. G.; Akimov, A. P. Izv. Akad. Nauk SSSR, Ser. Geol.; No. 1, 14-24(Jan 1971). (In Russian).

Results are given for the determination of the uranium content,

the form in which it occurs, and the microtopological distribution in samples in deep-lying rocks of the continental shelf and upper mantle. The fragment radiographic technique was employed. The uranium content of a large series of deep-lying rocks was determined: (1) in peridotites and eclogites from kimberlite pipes, (2) in metamorphic rocks of granulitic facies of the Anabarsk shield, and (3) in crustal eclogites of the Urals and Kirgiz. The information on the form of occurrence of uranium and the special features of its distribution in minerals and rocks are presented for the first time. (tr-auth.)

48670 PECULIARITIES OF THORIUM, URANIUM, AND POTASSIUM DISTRIBUTION IN THOLEIITIC–BASALTIC FORMATION ROCKS. Zolotarev, B. P.; Semenov, G. S. Sov. Geol.; No. 12, 29-41(Dec 1970). (In Russian).

Gamma spectrometry was used to determine the Th, U, and K contents of 11 traprock intrusions of the Siberian platform. Average values were 1.6 g Th/ton, 0.85 g U/ton, and 0.64% K. Depth differentiation of the original magma at a constant partial pressure of oxygen leads to increases of Th and U contents in the later differentiations. However, the rate of accumulation of Th and U relative to K is approximately the same. The differentiation of magma for an increase of oxygen partial pressure leads to a situation wherein for the later differentiations the U accumulation rate is smaller than that for Th, in relation to K. The final U concentrations in rocks of the tholeiitic-basaltic formation depend upon the processes of deep differentiation and contamination of the magma by other materials. (tr-auth.)

48671 FORMATION OF METASTABLE AND STABLE MODIFICATIONS OF IRIGINITE BY THE ACTION OF URANIUM-BEARING SOLUTIONS OF POWELLITE. Zhil'tsova, I. G.; Karpova, L. N.; Sidorenko, G. A.; Valueva, A. A. Geochem. Int. (Engl. Transl.); 7: No. 4, 688-92(Apr 1970).

Translated from Geokhimiya; No. 8, 1019-23(Aug 1970).

Acid (pH 3.15 to 3.75) solutions of uranyl nitrate containing 0.1 to 1.0% uranium act on synthetic powellite ($CaMoO_4$) under normal conditions to produce a metastable modification to iriginite $UO_2(HMoO_4)_2 \cdot 3\,H_2O$, whose deposition requires a considerable excess of U over Mo in the solution. This metastable form has properties intermediate between those of iriginite and calcium uranium molybdate. Nitrate solutions containing over 3% uranium act on synthetic powellite under normal conditions to replace the powellite spherulites by clumps of grains with a cryptocrystalline structure. The new phase is stable iriginite, which closely resembles the natural material. (auth)

Oceanography

Refer also to abstract 48646.

48672 (CONF-700965–1) DEPOSITION OF URANIUM IN THE SEDIMENT AND INTERSTITIAL WATER OF AN ANOXIC FJORD. Kolodny, Yehoshua (Hebrew Univ., Jerusalem (Israel). Dept. of Geology); Kaplan, I. R. (California Univ., Los Angeles. Inst. of Geophysics and Planetary Physics). [1970]. 43p. Dep. NTIS.

From International symposium on hydrogeochemistry and biochemistry; Tokyo, Japan (10 Sep 1970).

The distribution of uranium in the sediments of Saanich Inlet was determined using chemical fractionation methods to separate authigenic uranium from detrital uranium. $^{234}U/^{238}U$ activity ratios were found to be good indicators for determining the efficiency of the separation. Uranium concentration in the sediment shows a significant enrichment relative to deep sea sediment. Authigenic uranium correlates most strongly with the organic carbon content of the sediment, and is probably bound as organo-uranyl complexes. Approximately half the uranium in the sediment of the central fjord is organically complexed and the remainder is distributed among detrital minerals, authigenic tetravalent uranium and uranium adsorbed on organic matter. Uranium is highly enriched in interstitial water (both oxidizing and reducing waters with an Eh range of +380 mV to −140 mV) relative to its concentration in normal seawater. Its concentration appears to depend on the oxidation state and the organic content of the sediment. Concentration of uranium by the sediments was found to be very efficient in this environment. The residence time of uranium in the water column was found to be 3 or 4 orders of magnitude less than estimated for the open ocean. (auth)

48673 (UCSD–34-P-163-X-2) MEASUREMENTS OF BOMB-PRODUCED RADIOCARBON IN THE SURFACE AND SUBSURFACE WATER OF THE PACIFIC OCEAN. Interim Progress Report, March 1, 1970–February 28, 1971. Suess, Hans E.; Bien, George S. (Scripps Institution of Oceanography, La Jolla, Calif.). 1 Mar 1971. Contract AT(04-3)-34. 17p. Dep. NTIS.

Data tabulations are presented for the ^{14}C content in seawater samples collected from surface and subsurface water of the Pacific Ocean. (D.H.M.)

48674 RADIOISOTOPIC SAND-TRACER STUDY. Isotop. Radiat. Technol.; 8: No. 4, 392-5(Summer 1971).

Sand-labeling methods and sand-injection devices developed for tracing sediment movement on a dry beach, in a breaker zone, and in deep water and for field tests on the survey system are summarized briefly. (auth)

48675 OCEANOGRAPHY IN THE VICINITY OF AMCHITKA ISLAND, ALASKA. McAlister, W. Bruce (National Science Foundation, Washington, D. C.). Bioscience; 21: No. 12, 646-51 (15 Jun 1971).

From twenty-first annual AIBS meeting; Bloomington, Ind. (26 Aug 1970). See CONF-700843.

A survey was made to clarify the details of the physical and biological oceanography near Amchitka Island. Although there are two broad, sweeping easterly currents (Kuroshio and West Wind Drift) in the central North Pacific Ocean, the circulation near Amchitka is more directly influenced by the westward flowing Alaskan Stream, and by the complex patterns of exchange and mixing between the North Pacific and Bering Sea waters in the Aleutian Passes. Tidal currents are strong, and may change drastically in two weeks, producing major apparent shifts in circulation patterns. Biology and productivity were as expected in the central North Pacific. Concentrations at physical fronts between water masses result in wide scatter in relative species abundance and absolute biomass. (auth)

Seismology

48676 (CGS–746-120) EXPLOSION EFFECTS AND EARTHQUAKES IN THE AMCHITKA ISLAND REGION. Engdahl, E. R. (National Ocean Survey, Rockville, Md.). 29 Jun 1971. Contract AT(29-2)-746. 20p. Dep. NTIS.

Microearthquake monitoring by a network of seismographs located on Amchitka and nearby islands reveals that the nature of earthquake activity in this region is consistent with the hypothesis of underthrusting of the Aleutian arc by a rigid lithospheric plate. Observable effects of the Milrow nuclear explosion were small, of short duration, confined to the region immediate to the explosion, and were apparently independent of this geotectonic mechanism. (auth)

48677 (NVO–1163-TM-28) BASIC ELEMENTS OF TWO-DIMENSIONAL WAVE PROPAGATION IN HOMOGENEOUS, ISOTROPIC LAYERED ELASTIC MEDIA. Power, F. W.; Mueller, R. A. (Environmental Research Corp., Las Vegas, Nev.). Aug 1971. 26p. Dep. NTIS.

The boundary value problem of a spherically symmetric forcing function acting at an elastic radius in a layered half-space in which the layers are taken to be isotropic and elastic is formulated for two dimensional geometry. The basic elements of the theory are developed for completeness with the solution presented in finite difference form. The boundary value problem is modified so as to apply to underground nuclear detonations in either a half-space or a layered half-space and subsequently coded for digital computation. Utility of the finite difference wave propagation computer code (SHELP) for various ground motion studies is described. (auth)

48678 CORDILLERAN SECTION, 67th ANNUAL MEETING OF THE PALEONTOLOGICAL SOCIETY, PACIFIC COAST SECTION, AND THE SEISMOLOGICAL SOCIETY OF AMERICA, MARCH 25–27, 1971, RIVERSIDE, CALIFORNIA. Abstracts with Programs, Volume 3, Number 2, February 1971. Boulder, Colo.; Geological Society of America (1971). 213p. (CONF-710307(Absts.)).

Abstracts of the papers presented at the Cordilleran Section, 67th annual meeting of the Paleontological Society are given including 25 papers in the nuclear seismology section. (D.H.M.)

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ENGINEERING

Nuclear Explosions

Refer also to abstracts 48611, 48612, 48658, 48664, 48665, 48676, 48677, 48772, 49116, 49959, and 50596.

48679 (AD–721276) NUCLEAR EFFECTS TESTS. Material Test Procedure. (Army Test and Evaluation Command, Aberdeen Proving Ground, Md.). 31 Oct 1969. 19p. (MTP–5-2-522). NTIS.

The procedures provide general guidance for determining the ability of the missile and/or rocket system under test to withstand the effects of a nuclear weapon detonation relative to criteria expressed in applicable documentation. Procedures are given for evaluation to nuclear radiation, blast, thermal radiation, and electromagnetic pulse environments. (auth) (USGRDR)

48680 (AD–722252) NUCLEAR WEAPONS EFFECTS: DUST AND AIR TEMPERATURE ENVIRONMENT. Final Technical Report. Swatosh, James J. Jr.; Wiedermann, Arne H. (IIT Research Inst., Chicago, Ill.). Feb 1971. Contract DACA73-67-C-0018. 282p. (CERL-TM-S-2). NTIS.

The manual presents a computer program for calculating the dust and air temperature environment resulting from nuclear weapons detonations. The program can accommodate a wide variety of weapons detonations and ground surfaces. A weapons effects subroutine limits battle environment input data to the bare minimum. Dust concentrations can be calculated at any significant range from ground zero and at any height to which dust is raised by blast wind erosion of soil and subsequent air transport. The soil may be considered either uniform or variable in the path of the blast wave. Soils are specified by particle size and terminal velocity, size distribution, and erodible depth. Land use is accounted for. The topography is assumed to be flat or gently rolling. Multiple burst dust concentrations can be computed for variously timed detonations. The effect of prevailing winds is introduced after cessation of blast winds. Air temperature is treated as a dust-related phenomenon. The ground, heated by thermal radiation prior to arrival of the air blast, is eroded and transported by the blast wind. Its heat is transferred to air, primarily by convection, until thermal equilibrium is attained. The dust present from preceding bursts acts as a heat shield, transmitting only a portion of thermal radiation from succeeding bursts. (auth) (USGRDR)

48681 (FOA–4–4459) TRAJECTORY CALCULATIONS CONCERNING LEAKAGE FROM AN UNDERGROUND NUCLEAR EXPLOSION. Rydgren, Bo (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Apr 1971. 13p. (In Swedish). Dep. NTIS (U. S. Sales Only).

The propagation of a cloud from a leak from an underground nuclear explosion in Nevada was determined by using meteorological calculations of the trajectory and from samples of the airborne activity taken at stations along the trajectory. (Sweden)

48682 (NVO–544-1) COAL BREAKAGE WITH NUCLEAR EXPLOSIONS FOR IN SITU GASIFICATION. Lombard, David B. (Geo-Resource Associates, Arvada, Colo.). 30 Jun 1971. Contract AT(26-1)-544. 32p. Dep. NTIS.

A study is presented that examines the concept of breaking underground coal deposits with nuclear explosions in order to provide fracture permeability for subsequent in-place treatment. The treatment would presumably be aimed at converting the coal to methane gas. Four nuclear explosion cases were analyzed: a 100-kiloton chimney in the upper model interval; a 200-kiloton chimney in both levels; two 100-kiloton chimneys, together covering both intervals; and an array of seven 125-kiloton explosions designed to break both levels. Only coal that is in the chimney rubble is calculated in the first three cases. Fractured rock outside the chimneys is calculated for the array. Nuclear breakage of underground coal deposits is probably technically feasible. If an effective treatment method is developed, the costs of nuclear breakage in the overall economics of methane recovery would be minimal. The role of radioactivity and the possibility of subsidence during or after recovery of methane treatment should both be studied further. (auth)

48683 (NVO–1229-160) LONG-RANGE MONITORING NETWORK FOR AMCHITKA ISLAND, ALASKA. Essington, E. H. (Teledyne Isotopes, Palo Alto, Calif.). Jan 1971. Contract AT(29-2)-1229. 20p. Dep. NTIS.

A long-range monitoring network is recommended for nuclear testing on Amchitka Island, Alaska. This network is designed to verify that no radioactivity produced by underground nuclear explosions on Amchitka reaches surface or ocean waters. Details of the network are presented relative to the individual testing sites where nuclear events have been executed or are anticipated. The network presently includes the Long Shot and Milrow sites. Details of the portion of the network at the Cannikin site cannot be finalized until after the event. It is believed that this portion of the network will be similar to the portion covering Milrow. (auth)

48684 (ORNL–4646) THEORETICAL EVALUATION OF CONSUMER PRODUCTS FROM PROJECT GASBUGGY. FINAL REPORT, PHASE I: IMPACT OF HYPOTHETICAL RELEASES OF CONTAMINATED GAS IN THE SAN JUAN BASIN. Jacobs, D. G.; Barton, C. J.; Bowman, C. R.; Briggs, G. R.; Culkowski, W. M.; Kelly, M. J.; Rohwer, P. S.; Struxness, E. G. (Oak Ridge National Lab., Tenn.). Sep 1971. Contract W-7405-eng-26. 43p. Dep. NTIS.

The first phase of a theoretical evaluation of potential radiation exposures from Project Gasbuggy, dealing with the hypothetical domestic and commercial utilization of contaminated natural gas within the San Juan Basin, has been completed, and the results are reported in detail. Although none of the gas from the Gasbuggy well, the first of a planned series of nuclearly stimulated natural gas wells, has been introduced into the gas gathering and distribution system of the El Paso Natural Gas Company, the analysis was based on this system and on data from the production testing of the Gasbuggy well for maximum realism. The only long-lived radionuclides found in the Gasbuggy gas were ^{85}Kr, ^{3}H (tritium), and low concentrations of ^{14}C. The tritium, which will be present in natural gas combustion products as HTO, has the greater radiological impact and is considered in more detail. The concentration of these species in the cavity gas decreased as gas removed from the well was replaced by uncontaminated formation gas. Various pathways by which individuals living within the San Juan Basin could hypothetically be exposed to radioactivity from contaminated gas are considered, and potential doses are calculated. It was concluded that of those pathways considered, the critical exposure pathway would be domestic consumption of gas for cooking, and the critical population group would be composed of housewives in the Blanco camp adjacent to the Blanco process plant. Calculated doses are much lower than dose limits set by national and international authorities. (auth)

48685 (SU–326-P-31-2) USE OF NUCLEAR EXPLOSIVES FOR WATER RESOURCES DEVELOPMENT IN ARID REGIONS. Retief, Johannes V.; Kruger, Paul (Stanford Univ., Calif. Dept. of Civil Engineering). Jun 1971. Contract AT(04-3)-326. 108p. Dep. NTIS.

The feasibility of using nuclear explosives for the construction of crater reservoirs to store water in arid regions was investigated in relation to the special hydrologic conditions of arid regions, with its low and variable mean annual precipitation, erratic runoff, high evaporation rates, salinity problems and large sediment loads. As a result of smaller evaporation losses, crater reservoirs have a better hydrologic efficiency than conventional reservoirs. With storage capacity equal to the mean annual runoff of the river, crater reservoirs yield from 20 to 50% more water than conventional reservoirs. Alternatively, conventional reservoirs should be larger than crater reservoirs to produce the same yield. Seepage losses are high with crater reservoirs, but the seepage rate is reduced as sediment deposits accumulate in the crater. The seepage loss can be utilized through conjunctive development of surface and ground water. Hazards may severely limit the applicability of cratering nuclear explosions. Ground shock and air blast may require that the construction site be located in a remote area. Radiation contamination may have to be removed by several cycles of flooding and draining of the crater if the concentration in the water is above prescribed levels. Craters with a storage capacity larger than 10,000 acre ft can deliver water at a price less than $37/acre ft, which is the upper limit of prices of irrigation water. A 100,000 acre ft reservoir can deliver water at a cost of $14/acre ft. (auth)

48686 (UCRL–73022) PLOWSHARE APPLICATIONS AND CROSS SECTION UTILIZATION. Lessler, R. M. (California Univ., Livermore. Lawrence Radiation Lab.). 8 Feb 1971. 13p. (CONF-710301–5). Dep. NTIS.

From third conference on neutron cross sections and technology; Knoxville, Tenn. (15 Mar 1971).

The various Plowshare applications of underground nuclear explosions are outlined, and some of the neutron-induced reac-

tions that are involved are listed. The adequacy of existing neutron cross-section data for these reactions is evaluated, and the cross sections for which more data are needed are singled out and grouped according to a priority scheme. Three of the cross sections given highest priority according to Plowshare data needs are those for tritium produced in the ternary fission of ^{235}U by fission spectrum neutrons, the $^{17}O(n,\alpha)^{14}C$ reaction, and the $^{40}Ca(n,\alpha)^{37}Ar$ reaction. (auth)

48687 (UCRL-73256) SLOPE ANALYSIS FOR EXPLOSIVE EXCAVATIONS. Gates, Richard H. (California Univ., Livermore. Lawrence Radiation Lab.). Jul 1971. 26p. (CONF-710804-1). Dep. NTIS.

From thirteenth symposium on rock mechanics; Urbana, Ill. (30 Aug 1971).

The assessment of crater slope stability requires specific information on crater geometry, geologic conditions, and material properties at the site, including seepage and weathering characteristics of the materials. Fallback from dry rock media will behave as cohesionless material and may be studied by methods developed for the stability of rubble, talus, and rockfill. Factors of safety for the fallback portion of a crater slope should range between 1.1 and 1.5, and the rupture zone is buttressed by the fallback. Rupture zone materials in rock would most likely fail along surfaces of natural or blast-induced fractures if the strength of the intact rock is significantly larger than the frictional resistance to sliding along the fractures. The effects on slope stability of possible long-term changes in strength and seepage characteristics in response to weathering agents are hard to assess. The methods of analysis of explosive excavations are continuing to improve. Limit equilibrium techniques are satisfactory for design, but the continuum mechanics techniques are helpful in the research of rock behavior. (auth)

48688 GROUND MOTION AND ATMOSPHERIC PRESSURE WAVES FROM NUCLEAR EXPLOSIONS. Dahlman, O.; Israelson H.; Waegner, H. Nature (London) Phys. Sci.; 232: No. 30, 79(26 Jul 1971).

The long-period seismologic and microbarologic signals at Hafgors from the French test series in the south Pacific in the summer of 1970 are reported; the equipment used is stated to be operating at a sensitivity 10 to 50 times that of a standard seismological station. The observed arrival times for waves of period 30 sec were in good agreement with those calculated from distribution of lateral Rayleigh-wave velocities, and the maximum amplitude in the wave train occurred at a period of about 20 sec, and corresponded with ground motions of 0.18 μm and 0.24 μm for the explosions on May 30 and July 3, respectively. The first part of the record of microbarologic signals from the May 30 explosion showed a fundamental gravity mode, followed by a mixture of higher modes, and the measured travel time gave a group velocity of 304 m/sec. The first part of the microbarologic signal is known to be a function of the explosion yield, and if the variation of period with distance is taken into account the observed period of 120 sec corresponded to a yield of 600 kt. There seems to be no simple relation that is generally applicable by which the yield of an atmospheric explosion can be determined from recorded seismic signals; such signals depend not only on the charge size but also on explosion altitude and ground properties, and model experiments and theoretical calculations indicate that for charge size there exists an optimal explosion altitude, so that an explosion at that altitude gives larger seismic signals than for any other altitude. Rayleigh wave amplitudes appear to show a rather complex altitude dependence, and ground properties appear to have a great influence on the Rayleigh wave signal. (UK)

Facilities and Equipment

Refer also to abstracts 48637, 48716, 48900, 49205, 49350, 49519, and 49583.

48689 (AECL-3735) VIBRATION OF U-BEND SEGMENTS OF HEAT EXCHANGER TUBES. Lee, Lester S. S. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Jan 1971. 57p. Dep. NTIS (U. S. Sales Only). AECL $1.50.

Vibrations of the ring portion of the U-bend segment of a heat exchanger were studied. Both pinned and clamped end conditions are discussed. Vibrations of an incomplete ring fall into two independent classes, namely, the in-plane flexural vibration and the coupled twist-bending out-of-plane vibration. Effective length of a curved rod is defined as a measure of stiffness as compared with an equivalent straight bar. Strain gages were used in a simple experimental test to measure the natural frequencies of the vibration of an incomplete ring of Type 304 stainless steel. Results of the experimental tests and the theoretical predictions are close enough to justify the theoretical analysis. (auth)

48690 (IPPJ-DT-17) HIGH SPEED ELECTRO-MAGNETIC VALVE. Akiyama, Riuichi; Kawasaki, Sunao; Uchida, Taijiro (Nagoya Univ. (Japan). Inst. of Plasma Physics). Mar 1970. 41p. (In Japanese). Dep. NTIS (U. S. Sales Only).

In plasma experiments, it is often required to fill a vacuum vessel with a known quantity of gas at some predetermined time. For this purpose, electromagnetically or mechanically driven high-speed valves are used in most cases. For valves of this type, fundamental analyses have been performed to determine the relation between source voltage, stiffness of spring and static gas pressure, and valve characteristics of time interval (T) for which the valves open, and gas volume. These analyses resulted in findings that there is a theoretical lower limit of valve radius, driving impulse depending upon only total power, and high voltage is not necessarily useful. The driving circuit, gas flow measurement, and observation of T determined through such steps for the valve are reported. (Japan)

48691 (NYO-3930-13) LIQUID METAL BEARINGS TECHNOLOGY FOR LARGE, HIGH-TEMPERATURE, SODIUM ROTATING MACHINERY. PART I. SODIUM BEARINGS TEST FACILITY. PART II. SCREENING ANALYSIS OF BEARING SURFACE MATERIALS. Sixth Topical Report. Arwas, E. B.; Calabrese, S.; Eusepi, M.; Murray, S. F.; Newell, R.; Waldron, W. (Mechanical Technology Inc., Latham, N. Y.). Jul 1971. Contract AT(30-1)-3930. 161p. (MTI-71-TR-36). Dep. NTIS.

A sodium bearings test facility is described which was developed to provide a means for accurate and detailed measurement of the performance of large journal bearings to prove the theoretical predictions of turbulent lubrication theory including fluid inertia effects, and to obtain parametric test data on self-acting journal bearings lubricated with liquid sodium at elevated temperatures over the speed and load ranges of the bearings used in large, free-surface, sodium circulation pumps for breeder reactors. The results of the screening phase of an investigation of the use of coatings to protect the surfaces of fluid film bearings, lubricated with sodium at elevated temperatures, from damage during sliding contacts are described. Coatings such as borided molybdenum, borided 316 stainless, Colmonoy 5, Colmonoy 6, Stellite 6, nickel-chrome bonded chrome carbide LC-125, a BaF_2/CaF_2 eutectic solid film lubricant, and binderless, vapor deposited titanium carbide were stable after exposure to high temperature sodium for 640 hr. (J.R.D.)

48692 (ORNL-TM-3381) USE OF WARM WATER FOR HEATING AND COOLING PLANT AND ANIMAL ENCLOSURES. Beall, S. E.; Samuels, G. (Oak Ridge National Lab., Tenn.). Jun 1971. Contract W-7405-eng-26. 60p. Dep. NTIS.

A method of utilizing the warm water from the condenser of a power plant to heat and cool greenhouses and animal enclosures is described. Most of the heat is exchanged by direct contact between air and the condenser cooling water in fibrous pads with the remainder being transferred to the air from finned tubes for humidity control. As this method was also used to cool the enclosures in the summer, the system can be used as the power plant heat rejection system. Using the Fort St. Vrain Nuclear Generation (which uses cooling towers to reject 500-Mw heat) of the Colorado Public Service Company of Colorado as a site for study, it was found that the cost of the equipment required to utilize the warm water was in the range of the cost of heating systems for conventional greenhouses. Since the cost of heating greenhouses in the Denver area is over $5,000 per acre per year, the potential value of the heat being wasted from the plant is greater than $1,000,000 per year. (auth)

48693 (ORNL-TM-3443) ALTERNATIVES FOR STORAGE OF DESALTED WATER. Michel, John W. (Oak Ridge National Lab., Tenn.). 1 Jun 1971. 9p. (CONF-710435-1). Dep. NTIS.

From Panel on the storage and transport of water from nuclear desalting plants; Vienna, Austria (5 Apr 1971).

Three alternative systems for storage of product water from a desalination plant are briefly described and the overall storage costs are compared. A floating plastic or rubber bay design is shown to be worthy of further study. (auth)

48694 (RDT-E-4-19-T) PLUGGING TEMPERATURE INDICATOR ASSEMBLY FOR SODIUM SERVICE. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Aug 1971. 18p. LMEC.

A standard prescribing requirements for plugging temperature indicator assembly for sodium service for nuclear and associated applications is presented.

48695 (RDT-F-6-11-T) FABRICATION OF PIPING SUBASSEMBLIES FOR LIQUID METAL SERVICE. (Division of Re-

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actor Development and Technology (AEC), Washington, D. C.). 23 Aug 1971. 10p. LMEC.

A standard prescribing requirements for fabrication of piping subassemblies for liquid metal service for nuclear and associated applications is presented.

48696 (TID-4100(Suppl.64)) ENGINEERING MATERIALS LIST. Smith, Richard J.; Sachs, Francis L.; Clark, Willie E. (eds.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Jul 1971. 46p.

Fourteen packages of engineering drawings and specifications are presented. Packages of drawings are included on connectors for remote installation, liquid scintillation detector for alpha-particle energy resolution, tube cleaning machine, chemical processing equipment, off-gas heater and silver reactors, uranium oxide to UF_6 conversion facility, extended range high-speed framing camera, numerically controlled machines, automated welder, solvent purity meter, field instrument for detecting airborne halogen compounds, data output system, interactive graphic display system for hydrologic analysis, and FFTF hybrid computer interface. A subject index is included. (L.C.L.)

48697 (TRG-Report-2158) A 1 INCH SODIUM TECHNOLOGY TEST LOOP OF ADVANCED DESIGN. Swinhoe, R.; Hamer, A. N. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). Feb 1970. 38p. Dep. NTIS (U. S. Sales Only). UK 30p.

A sodium rig was constructed the purpose of which is to test new devices and systems during their development stages when the time scales for individual tests are unpredictable. The rig consists of a permanent sodium supply section capable of providing a purge flow of 2 gpm at 400°C. Oxygen impurity levels can be reduced below 5 ppM. An experimental area containing four test stations, to which the test sections can be attached is also included. These may each contain 200 lb of sodium and operate at temperatures up to 650°C. The circuitry is arranged so that a test section may be installed, operated, and removed without interfering with the experiments in progress on adjacent test sections. The main features of the flow diagram are described and information about the various circuit elements is included. The performance of the rig during its commissioning trials and the first 2½ year's operation is reviewed. (J.R.D.)

48698 (WARD-3762-12) MEDIUM CAPACITY SODIUM PUMP DESIGN STUDY. PHASE II. Final Report. (Westinghouse Electric Corp., Pittsburgh, Pa. Advanced Reactors Div.). Jul 1970. Contract AT(30-1)-3762. 844p. Dep. NTIS.

Design considerations, features, alignment procedures and operation of the 60,000 gpm medium capacity sodium pump, as well as the effect of analytical work on the design are described. An equipment specification for procurement of a prototype pump is included, with recommendations for further test and development. Configuration, material selection, load capacities, flow estimates, and alignment requirements are presented for the sodium lubricated, four pocket, rigid hydrostatic bearing recommended for the pump. A unique seal system utilizing self-lubricating rubbing gas seals is recommended for the pump. The estimated performance and wear life for this system satisfies the requirements of low leakage and long life. (auth)

48699 (WERL-TAGOV-1) ANALYSIS OF A FORCED-FLOW BARE TUBE HEAT EXCHANGER FOR CONDENSING SHELL-SIDE STEAM IN THE PRESENCE OF AIR AND HYDROGEN. Ayers, D. L.; Beecher, D. T. (Westinghouse Research Labs., Pittsburgh, Pa.). 14 Jun 1971. 76p. Dep. NTIS.

An analysis was developed to predict heat transfer and pressure drop for a forced-flow bare-tube heat exchanger condensing saturated shell-side steam in the presence of air and hydrogen. A digital computer program written to evaluate the analysis is described. The program is used in a parametric study of heat transfer performance as a function of exchanger geometry, gas velocity and coolant flow rate. Results show that an exchanger can be designed with a capacity which will exceed the desired heat transfer rate of 15,000 Btu/sec in the prescribed geometric envelope of 6.5 by 5.3 by 2 feet. (auth)

48700 (Y-SC-10) MACHINING AND GAGING INFORMATION 1970 ANNUAL INDEX. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 30 Jun 1971. Contract W-7405-eng-26. 241p. Dep. NTIS.

This index contains a compilation of all information entries to the M.A.G.I.C. data base during Calendar Year 1970. The index consists of five sections: a title index, a key word index, an author index, a corporate author index, and a bibliographic section. Each bibliographic entry is arranged according to corporate author and includes a title, personal author, report designation, abstract, report availability, and key word descriptors. (auth)

48701 INVESTIGATION OF A DEVICE USING RADIATION TO CHARGE AND COLLECT PARTICULATE MATTER. Dickter, William; Schultz, M. A. (Pennsylvania State Univ., University Park). Nucl. Technol.; 12: No. 2, 243-52(Oct 1971).

Early attempts to charge and collect dust particles by radiation ionization were unsuccessful because of the unavailability of suitable strength radiation sources and proper geometries. A series of experiments using an ionization chamber-precipitator which indicates that suitable charging can be obtained from a 165 Ci radioactive cobalt-60 source is described. Collection efficiencies of 70% have been measured with a non-optimum geometry. The measurements were made using an aerosol of high resistivity salt particles having a median diameter of 0.7 microns. Theoretical considerations indicate that higher efficiencies can be obtained by changing electrode spacing in the ionization chamber-precipitator. (auth)

48702 APPARATUS FOR ELECTRON BEAM IRRADIATION. Davison, William Henry Thomas (to TI (Group Services) Ltd.). British Patent 1,241,371. 4 Aug 1971. Filed 16 Apr 1969.

The apparatus described comprises an evacuated chamber having a window structure consisting of an inner electron-permeable membrane that is substantially impermeable to gas and an outer electron-permeable membrane that is gas-permeable. Means are provided for passing cooling gas between the membranes in a direction transverse to the window structure. Means are also provided for moving material to be irradiated past the window structure in the direction of gas flow. The material of the outer membrane is such that it intercepts less than about 50% of the electrons reaching it, and may consist of an openwork structure, such as wire mesh, ribbons or perforated sheet material. The total mass thickness of the inner membrane, the gas between the membranes, and the solid parts of the outer membrane are less than half the range of the generated electrons. (UK)

48703 SPECIAL TECHNIQUES USED IN IRRADIATION DEVICES. Bull. Inform. Sci. Tech. (Paris); No. 153-154, 165-73 (Nov-Dec 1970). (In French).

A new technique for measuring length or diameter variations using microwave resonant cavities was investigated. Various devices fitted with this equipment have been in operation in Siloe, Melusine, and BR_2 for measurements on tensile or compressive creep, and swelling or expansion. Temperature measurements were made easier by the industrial development of small diameter thermocouples with mineral insulators, and by making pressure measurements with a new captor device. The use of a Cyrano device allowed the nuclear power during irradiation to be measured. The standardization of some parts of the control devices is described, in particular, measurement and recording of the intensity of an alternating current regulated by thyratrons, and continuous control and regulating devices for irradiation furnaces. (France)

48704 FRENCH-BRITISH LOOP. Bull. Inform. Sci. Tech. (Paris); No. 153-154, 157-60(Nov-Dec 1970). (In French).

The device is a closed loop with a circulating gas; part of the loop penetrates into the Siloe core. Graphite-moderated and gas-cooled (CO_2) reactors were investigated. The device presents two loops mounted in parallel, fed with a gas circulator. The main loop is under irradiation, the other loop maintains a constant gas composition. The gas control is accomplished using a Computer Acquisition and Recording on Loop Experiments system (CAROLE system). The loop was constructed in collaboration with U.K.A.E.A. (France)

48705 IMPROVEMENTS IN OR RELATING TO DEVICES FOR ESTIMATING THE STRESS IN CONCRETE STRUCTURES. Kinkead, Alfred Norman (to United Kingdom Atomic Energy Authority). British Patent 1,233,691. 26 May 1971. Filed 10 Jan 1969.

Reference is made to the instrumentation of reactor concrete pressure vessels for the monitoring of stress. It is common practice to employ embedded strain gauges at various parts of the concrete, from which the stress can be calculated, knowing the modulus. The validity of this method depends on the modulus remaining substantially constant; this value, however, can vary widely during the life of the concrete, and it is evident that it is advantageous to measure the stress in the concrete directly and to monitor it while the pressure vessel is in use. In the system described, the concrete structure is provided with a bore extending into it from one face, with a member located in the bore wall whose deflection in terms of applied stress is known. This member may comprise two rings at right angles joined at diametrically opposite points where they intersect. (UK)

48706 CONTROL OF AN INSTALLATION FOR THE IMPREGNATION AND GAMMA IRRADIATION OF WOOD. Silie; Worm;

Taieb (Ecole Superieure d'Ingenieurs d'Electrotechnique et d'Electronique, Paris). Elec.-Electron. Mod.; 41: 10-16(Dec 1970-Jan 1971). (In French).

An installation for impregnating and irradiating wood is described. Inside an irradiation chamber the wood is placed in metallic baskets on a moving conveyor. In order that the different types of wood receive the appropriate doses, it is necessary to know the doses received at the sides and at the center of the baskets. An IBM 1130 computer was used for the calculations which were made assuming firstly a uniform source of radiation, and then a source in the form of bars. The ATOME program enabled the doses to be determined at the sides and center of a basket traversing the irradiator at constant velocity when the contents of the baskets were the same. The results from the calculations were also extended to the case when the baskets did not contain the same materials. (France)

48707 PROCESS FOR MEASURING COMPRESSIVE STRESSES, A COMPRESSION MEASURING DEVICE AND THE UTILIZATION OF THE PROCEDURE. Beaujoint, Nicolas; Lemarquis, Jean-Claude; Lida, Maurice; Pinot, Gerard (to Electricite de France). French Patent 2,036,419. 14 Dec 1970. Filed 13 Mar 1969. (In French).

A procedure for measuring the compressive stresses in a mass of material is described. In particular, the stresses in the prestressed concrete walls of a reactor vessel are considered. A given volume of material is isolated from a uniform stress field. The deformation produced by the field is measured with a first extensometer outside this isolated region. A deformation identical to that recorded by the first extensometer is obtained on a second extensometer placed in the isolated region. The compression-measuring device is described. (France)

48708 LIMIT PRESSURE OF SPHERICAL SHELLS SUBJECTED TO EXTERNAL AXIAL FORCE. Palusamy, S. (Sir George Williams Univ., Montreal). Nucl. Eng. Des.; 16: No. 1, 13-23(May 1971).

Upper and lower bound analyses are presented for a spherical shell subjected to internal pressure and external axial force; the axial force is considered proportional to the pressure. The bounds are compared for various geometrical parameters. Comparison of analytical results with the experiment shows very good agreement. (auth)

Heat Transfer and Fluid Flow

Refer also to abstracts 48692, 48697, 48699, 48836, 48874, 51078, and 51081.

48709 (AEC-tr-7181) INVESTIGATIONS OF THE PROFILES OF SPEED IN THE ENTRANCE SECTOR OF A DENSELY PACKED CLUSTER OF RODS. Subbotin, V. I.; Ushakov, P. A.; Levchenko, Y. D.; Bibikov, L. N. Translation of Russian report. 22p. Dep. NTIS.

Velocity profiles at the entrance region of a densely packed cluster of rods were investigated. The measurements were carried out in a wind tunnel in which the air flow was created by a 2100 rpm centrifugal fan that developed an output of 10,000 m^3/hr. The analysis of experimental data permitted the velocity profiles along the axis of symmetry of the channel to be determined. (R.C.K.)

48710 (FEI-224) SEMI-EMPIRICAL THEORY OF THE HEAT EXCHANGE CRISIS DURING CHANNEL BOILING. Kirillov, P. L. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, [Obninsk]. Fiziko-Energeticheskii Institut). 1970. 37p. (In Russian). Dep. NTIS (U. S. Sales Only).

Several approaches to the study of the heat exchange crisis in channels were examined. These were purely empirical approaches based on a series of models from which a variety of formulas may be obtained. The basic equation of equilibrium in liquid films was analyzed, and methods were proposed for calculating separate components of this equation. It was shown that the use of two empirically determined quantities — the fraction of the liquid flowing in a film, and the mass transfer coefficient — contributes to a solution of the crisis problem. (tr-auth)

48711 (IDO-ITR-110) COMPUTER PROGRAM FOR STEAM AND WATER PROPERTIES FROM THE ASME (1967) IFC FORMULATIONS. (NRTS COMPUTER PROGRAM NO. 40,0969). Brist, A. M. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Mar 1969. Contract AT(10-1)-205. 64p. Dep. NTIS.

Subroutines used to calculate various single and two-phase properties of liquid water and steam from the ASME (1967) formulas that have been adopted by the International Formulation Committee (IFC) of the Sixth International Conference on the Properties of Steam are presented. These subroutines are used to calculate enthalpy, specific volume, internal energy, coefficients of cubical expansion and compressibility, and specific heat capacity as functions of pressure and temperature. The saturation and two-phase properties are available also. Previous steam table formulas were troublesome because the curves were not smooth and the derivatives were difficult to obtain and usually unreliable. The (1967) ASME formulas and their derivatives appear to be smooth except in the compressed liquid region near the critical point. This package of subroutines was requested by the SPERT and LOFT projects to develop and improve transient hydraulic codes. New steam property routines obtained from this package will be used by HYDRAX and RELAP2, which describe reactor behavior situations such as power bursts, loss of pressure and loss of coolant accidents. This program was written for the IBM 7044 and its programming language is FORTRAN IV. (auth)

48712 (KFK-tr-365) PRESSURE LOSS IN AXIAL-FLOW-THROUGH ROD BUNDLES. Sheynina, A. V. Translated by Rosemarie Corssen (Kernforschungszentrum, Karlsruhe, Ger.), from pp S.210-23 of Zhidkie Metally (Sbornik Statey), Atomizdat, Moscow, 1967. 20p. (In German). Dep. NTIS (U. S. Sales Only).

Pressure loss in axial flow through various arrangements of rod bundles was experimentally studied. Distilled water of 18 to 80°C was pumped at 70 m^3/hour at a pressure of 200 m water column. After flowing through the heat exchanger, the water traversed four parallel Venturi tubes and a measuring loop. Arrangements of rods and cooling ribs were presented in three tables. Experimental findings were depicted in 10 figures. (H.B.G.)

48713 (RD/B/M-1955) THERMODYNAMIC AND TRANSPORT PROPERTIES OF AIR AND CO_2. Pirie, M. A. M. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Mar 1971. 34p. Dep. NTIS (U. S. Sales Only).

The thermodynamic and transport properties necessary for heat transfer and gas flow experiments using air and CO_2 are given in graphical form. They are presented in SI units with conversion factors to allow other systems of units to be obtained. (auth)

48714 (RISO-M-1383) POSTBO: A TIME DEPENDENT ONE DIMENSIONAL POST-BURNOUT HEAT TRANSFER CODE. Valko, Janos (Danish Atomic Energy Commission, Risoe. Research Establishment). May 1971. 22p. Dep. NTIS (U. S. Sales Only).

The program described calculates the heat transfer in a boiling water channel up to and after the point where a given burnout condition is reached. A guide for use of the program is included together with a test case. (auth) (Denmark)

48715 POLYNOMIAL REPRESENTATION OF THE THERMODYNAMIC PROPERTIES OF SATURATED WATER AND STEAM BETWEEN 10 AND 180 BAR. Goemans, T. (Delft Univ. of Tech., Netherlands). Nucl. Eng. Des.; 16: No. 2, 179-92(1971).

A method is proposed for obtaining simple polynomial expressions for the thermodynamic properties of water and steam along the saturation line. The advantages of using Chebyshev polynomials in the approximation of a continuous function are outlined and an algorithm based on a least squares approximation in terms of a sum of Chebyshev polynomials is presented. For both water and steam the specific volume, enthalpy and entropy at saturation are approximated both as a function of pressure and temperature. Two pressure ranges (10 to 100 bar and 100 to 180 bar) and two temperature ranges (180 to 310°C and 300 to 360°C) are used. (auth)

48716 SPEED OF SOUND IN NON-EQUILIBRIUM GAS-LIQUID FLOW: PREDICTING THE ONSET OF CHOKED FLOW IN THE VENTS OF A SODIUM-WATER HEAT EXCHANGER. Baum, M. R.; Horn, G. (Central Electricity Generating Board, Berkeley, Eng.). Nucl. Eng. Des.; 16: No. 2, 193-203(1971).

In the event of a water leak into the sodium in a sodium/water heat exchanger, the products of the reaction must be vented from the system. In order to predict the possible behavior of the two-phase reaction products as they are expelled through the venting system, an analysis has been performed to determine the speed of sound and the factors affecting the onset of choking in a gas-liquid bubble flow. In particular, the influence of velocity and temperature nonequilibrium between the phases is examined. (auth)

48717 FREE CONVECTION HEAT TRANSFER BETWEEN VERTICAL PARALLEL PLATES. Nagendra, H. R.; Tirunarayanan (Indian Inst. of Science, Bangalore). Nucl. Eng. Des.; 15: 17-28(Mar 1971).

A new mathematical model for the solution of the problem of free-convection heat transfer between vertical parallel flat iso-

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thermal plates under isothermal boundary conditions, has been presented. The set of boundary-layer equations used in the model are transformed to nonlinear-coupled differential equations by similarity-type variables as obtained by Ostrach for vertical flat plates in an infinite-fluid medium. By utilizing a parameter η^*_w to represent the outer boundary, the governing differential equations are solved numerically for parametric values of Pr = 0.733, 2 and 3, and η^*_w = 0.1, 0.5, 1, 2, 3, 4,... and 8.0. The velocity and temperature profiles are presented. Results indicate that η^*_w can effectively classify the system into (1) thin layers where conduction predominates, (2) intermediate layers, and (3) thick layers whose results can be predicted by the solutions for vertical flat plates in infinite-fluid medium. Heat-transfer correlations are presented for the three categories. Several experimental and analytical results available in the literature agree with the present correlations. (auth)

48718 FREE CONVECTION HEAT TRANSFER FROM VERTICAL CYLINDERS. PART II. EXPONENTIAL SURFACE TEMPERATURE VARIATION. Nagendra, H. R.; Tirunarayanan, M. A.; Ramachandran, A. (Indian Inst. of Science, Bangalore). Nucl. Eng. Des.; 16: No. 2, 163-8(1971).

Investigations on laminar free convection heat transfer from vertical cylinders and wires having a surface temperature variation of the form $T_w - T_\infty = M e^{mx}$ are presented. As in Part I for power-law surface temperature variation, the axisymmetric boundary layer equations of mass, momentum, and energy are transformed to more convenient forms and solved numerically. The second approximation refines the results of the first up to a maximum of only 2%. Analysis of the results indicates that cylinders can be classified into the same three categories as in Part I, namely, short cylinders, long cylinders, and wires, heat transfer and fluid flow correlations being developed for each case. (auth)

48719 FREE CONVECTION HEAT TRANSFER FROM VERTICAL CYLINDERS. PART I. POWER LAW SURFACE TEMPERATURE VARIATION. Nagendra, H. R.; Tirunarayanan, M. A.; Ramachandran, A. (Indian Inst. of Science, Bangalore). Nucl. Eng. Des.; 16: No. 2, 153-62(1971).

Investigations are reported of laminar free convection heat transfer from vertical cylinders and wires whose surface temperature varies along the height according to the relation $T_w - T_\infty = Nx^n$. The set of boundary layer partial differential equations and the boundary conditions are transformed to a more amenable form and solved by the process of successive substitution. Numerical solutions of the first approximated equations (two-point nonlinear boundary value type of ordinary differential equations) bring about the major contribution to the problem (about 95%), as seen from the solutions of higher approximations. The results reduce to those for the isothermal case when n = 0. Criteria for classifying the cylinders into three broad categories, viz., short cylinders, long cylinders, and wires, have been developed. For all values of n the same criteria hold. Heat transfer correlations obtained for short cylinders (which coincide with those of flat plates) are checked with those available in the literature. Heat transfer and fluid flow correlations are developed for all the regimes. (auth)

48720 TRANSIENT BOILING HEAT TRANSFER TO WATER. Johnson, H. A. (Univ. of California, Berkeley). Int. J. Heat Mass Transfer; 14: 67-82(Jan 1971).

Experimental transient boiling heat transfer results in water for exponential heat inputs to thin metallic ribbons of $0.015 \times 10^6\ e^{t/\tau_0}$ Btu/ft^2 hr are compared with steady state predictions. The nominal values of controlled variables included velocity: ≤1 to 14 ft/sec; pressure: 14.7, 500, 1000, 2000 psia; subcooling: ≤10, 42, 112°F; exponential period: 5, 15, 50 msec. (auth) (UK)

48721 VOID FRACTION AND STABILITY OF NATURAL CIRCULATION WATER BOILING IN A VERTICAL ANNULUS HEATED INTERNALLY. II. STABILITY ASPECTS WITH SINE-SHAPED HEAT FLUX. Dijkman, F. J. M. (Eindhoven Univ. of Tech., Netherlands). Nucl. Eng. Des.; 15: 90-5(Mar 1971).

In a boiling water channel with natural circulation, spontaneous oscillations can occur under operating conditions, as defined by channel power, pressure, and inlet subcooling. The influence of a sine-shaped heat flux on the steady state and dynamic behavior of a channel was investigated by comparing results with those obtained with an element with uniform heat flux. The effect was negligible on the steady state performance but very large on the dynamic behavior. With the sine-shaped heat flux no oscillations developed. Stability decreased with increasing channel power but not to the extent that obvious instabilities could be observed. It is concluded that instability indications obtained with uniform heat flux must be considered with reservation. (auth)

48722 PARAMETRIC ANALYSIS OF LYON'S INTEGRAL EQUATION FOR LIQUID-METAL HEAT TRANSFER COEFFICIENTS. Rust, J. H. (Georgia Inst. of Tech., Atlanta). Nucl. Eng. Des.; 16: No. 3, 223-36(1971).

A parametric analysis is made of Lyon's integral equation for liquid-metal heat transfer coefficients. The parameters studied are velocity profiles, eddy diffusivities for momentum transfer, and eddy diffusivity ratios. The results indicate that computed Nusselt numbers are not highly sensitive to the selected velocity profiles or eddy diffusivities for momentum transfer. Nusselt numbers are dependent upon eddy diffusivity ratios and expressions proposed by Deissler or Mizushina and Sasano appear to produce the best results. (auth)

48723 ONE-CHANNEL NON-LINEAR DIGITAL MODEL FOR BOILING WATER HYDRODYNAMICS. Dijkman, F. J. M.; Sluiter, M. L. C. (Eindhoven Univ. of Tech., Netherlands). Nucl. Eng. Des.; 16: No. 3, 237-48(1971).

A digital model was developed based on conservation of mass, energy, and momentum. The equations were supplemented by suitable correlations for slip factor, two-phase friction multiplier, and subcooled boiling parameter. The CSMP program of IBM was used for the solution. The purpose of the model was to support a number of experiments performed to study the phase relationship between void fraction and inlet flow rate in a nautral-circulation boiling-water channel, and the effect of a sine-shaped heat flux on the stability of the system. The qualitative effects were represented very well and the quantitative agreement with experimental results was promising. (auth)

48724 APPROXIMATE SOLUTION OF FLOW AND HEAT TRANSFER THROUGH NON-CIRCULAR CONDUITS WITH UNIFORM WALL TEMPERATURE AND HEAT GENERATION. Casarella, Mario J.; Laura, Patricio A.; Ferragut, Nelson (Catholic Univ. of America, Washington, D. C.). Nucl. Eng. Des.; 16: No. 4, 387-98(1971).

The analytical solution for flow and heat transfer through conduits with heat sources in the fluid stream is studied. The flow is assumed to have a steady uniform velocity profile defined as slug flow. A variety of conduits of different cross-sectional shapes is analyzed in a unified manner by mapping the cross section of the duct onto a unit circle and then transforming the governing equations. The transformed equations are solved using a weighted residuals approach. Solutions for the dimensionless mixing temperatures and Nusselt numbers are obtained for conduits of different cross-sectional shapes (square, hexagon, circle, corrugated, cardioid). In the case of a square duct the results are in excellent agreement with the exact values. The method is applicable to conduits of arbitrary shape and it may prove useful to design engineers since conduits of complicated boundary shape are commonly used in aerospace vehicles, nuclear reactors, etc. (auth)

Isotope Technology

Refer also to abstracts 48470–48472, 48532, 48701, 48759, 48760–48763, 48769, 49379, 49410, 50272, 50273, 50600, 50615, 50624, 50712, 51157, 51197, and 51211.

48725 (AD–718897) QUARTERLY OPERATING REPORT FOR RADIOISOTOPIC POWER GENERATORS OF THE U. S. NAVY. VOLUME 4, NUMBER 4. Report from October 1–December 31, 1970. (Naval Nuclear Power Unit, Fort Belvoir, Va.). 36p. NTIS.

The objective of the report is to accumulate and disseminate information concerning the application and operation of radioisotopic power generators (RPGs) within the Navy. It will be noted that all RPGs presently listed are radioisotope thermoelectric generators (RTGs). Unless specifically identified as an engineering evaluation, items contained in this report are presented as an impartial collection of facts, observations, and other information. An automatic weather station powered by the Sentinel-8 was emplaced on San Miguel Island off the California coast. Three URIPS-powered transponder systems were implanted near Midway Island by PMR in early October. Continued testing of the TRACS-25A indicated that the power output of this generator has dropped to approximately 5.8 watts. This required the reassignment of the Sentinel-25C3 to NUC-San Diego for use in an internal wave experiment in place of the TRACS-25A. Malfunctions in the buoy electronic systems have temporarily put the network of nuclear NOMADS in the Gulf of Mexico out of service. A contract modification was effected to make four recently ordered 25 watt generators suitable for deep-sea applications. (auth)

48726 (CONF-710402–(Vol.3), pp IV.94–8) ^{88}Y: A NEW REPLACEMENT FOR ^{124}Sb IN A NUCLEAR MATERIALS ASSAY SYSTEM. Kull, Lorenz A.; Beyster, J. R. (JRB Associates, La Jolla, Calif.); Schillaci, Mario E. (Los Alamos Scientific Lab., N. Mex.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

A number of neutron sources have been studied for application in nondestructive assay systems for fissionable material under the auspices of the AEC Nuclear Materials Safeguards Program. One of the assay devices which showed promise of providing useful assay data on the fissile content of low to moderate enrichment samples was designed around an $^{124}Sb-Be$ source. A survey of photoneutron sources showed that the $^{124}Sb-Be$ source is an adequate, but not the optimum choice for this assay application. From a technical standpoint, the $^{88}Y-Be$ source is better than the $^{124}Sb-Be$ for a fissile material assay system. However, up to now the economics of the situation have dictated that ^{124}Sb be used in building a practical device. Recent studies have shown that certain high energy accelerators in the 10^8 to 10^9 eV range can be used to produce high yields of radioisotopes which are not readily produced in reactors or low-energy cyclotrons at the present time. A feasibility study showing that ^{88}Y sources could be produced at the Los Alamos Meson Physics Facility (LAMPF) at a cost which competes favorably with ^{124}Sb in the present application is presented. Details of the source preparation are included. (auth)

48727 (CONF-710402-(Vol.3), pp IV.99-104) MODERATOR INVESTIGATIONS ON ^{252}Cf FOR NON-DESTRUCTIVE ASSAY OF FISSIONABLE MATERIALS. Forster, R. A.; Menlove, H. O. (Los Alamos Scientific Lab., N. Mex.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

The Nuclear Safeguards Research Program at the Los Alamos Scientific Laboratory includes the application of radioactive neutron sources to the assay of fissionable materials. Radioactive sources provide inherent simplicity and reliability at nominal cost, although they lack some of the flexibility and high intensity of accelerator neutron sources. The source which has received the most attention is ^{252}Cf. Neutronics calculations using the DTF-IV neutron transport code have provided tailored neutron spectra for different moderator configurations. Folding in these spectra with appropriate sample cross sections and detector responses yields detector counting rates, signal-to-background ratios, and fissile-to-fertile reaction rates. By considering various moderators it is possible to increase substantially the signal from the sample and the signal-to-background ratios. Such calculations have provided guidance for the design of a fuel pin assay assembly to measure the fissile component in low enrichment reactor fuels. A prototype fuel pin assay system has been designed and constructed and will be evaluated in a major industrial fuel fabrication facility. (auth)

48728 (DP-1267) SAVANNAH RIVER LABORATORY ^{60}Co POWER AND HEAT SOURCES. Quarterly Progress Report, October-December 1970. Angerman, C. L.; Ross, C. P. (comps.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Mar 1971. Contract AT(07-2)-1. 26p. Dep. NTIS.

Wafers of CoO, $Co_{0.5}Mg_{0.5}O$, and $CoAl_2O_4$ were irradiated successfully to specific activities of up to 700 Ci/g. The strength of 90% dense $CoAl_2O_4$ is 12,000 psi, or twice the strength of the other two oxides at the same density. Fracture of $Co_{0.5}Mg_{0.5}O$ wafers by a diametrical compression test yielded the least fines; fracture of CoO wafers resulted in the most fines. CoO was more resistant to corrosion than the other two compounds during 9-week tests in fresh water at 125°C flowing at 10 ft/sec. The thermal conductivities of the three oxide compounds, which were calculated from measured thermal diffusivities, are relatively low, typical of most ceramic materials. The walls of rhenium capsules containing unirradiated oxides were blistered and thinned after up to 1000 hr at 1500 to 1850°C due to vapor transport of rhenium within the capsules. Inconel 600, Hastelloy C, and Hastelloy X capsules containing unirradiated cobalt metal were intact after heating for up to 30,000 hr at 1000°C; a similar Haynes 25 capsule failed after 30,000 hr at 1000°C due to oxidation. Hastelloy X has been selected as the capsule and pin material for the WANL 30 kw(t) Demonstration Unit. (auth)

48729 (GEMS-401) MAGNETIC FIELD MEASUREMENT AND ANALYSIS. PART 3. SNAP-27 PROGRAM. Final Report. Wouch, G. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). 10 Jul 1968. Contract AT(30-1)-3535. 27p. Dep. NTIS.

The Mod 10 Generator Assembly and the Mod 10 IPU were subjected to various magnetic environments. The radial magnetic field data were analyzed using the multipole resolution of magnetic fields. The results were compared with those previously obtained. This comparison shows that using two methods of measurement there was fairly good agreement in the numbers obtained. Using the multipole resolution method, however, greater accuracy is obtained because of the greater amounts of data taken into account. (J.R.D.)

48730 (N-71-15815) VACUUM-PACKAGED CESIUM FOR NUCLEAR THERMIONIC DIODES. Morris, James F. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Jan 1971. 9p. (NASA-TM-X-2152; E-5950). NTIS.

Out-of-core nuclear thermionics places special demands on the physicochemistry of the converters. The emitters, collectors, and cesium require careful preparation to insure diode performance. For cesium, vacuum packaging allows excellent quality control. Providing this assurance, though, meant developing a new dispensing train and vacuum processing station. These designs and the resulting baked-out, brazed-shut molybdenum capsules for cesium are discussed. (auth) (STAR)

48731 (NUMEC-3292-21) 12" PRODUCTION COLUMN EVALUATION. Fersch, K. E. (Nuclear Materials and Equipment Corp., Lewiston, N. Y. Niagara Div.). 15 Dec 1970. Contract AT(40-1)-3292. 19p. Dep. NTIS.

On February 1, 1969, a new 12 inch diameter column with a packed depth of 54 feet and using a vertical tube reboiler was incorporated in the boron-10 isotope separation cascade. Additional separative capacity was required to meet anticipated demands for enriched boron-10. The additional column increased plant productivity from 431 to 594 kgs per year of enriched boron-10 as complex and allowed the cost of boron-10 as complex to be reduced from $3.81 to $2.76 per gram of contained boron-10. It would require a $452,550 reduction in operating cost to accomplish this same cost reduction. The $126,000 capital addition was found to have paid for itself in 3.4 months. A technical evaluation of the column was made where various technical functions were determined. These include column holdup as a function of vapor velocity; differential pressure as a function of vapor velocity; and, column isotopic equilibrium time. The column was also found to have met the conservative estimate of 50 separating stages which is discussed along with an evaluation of the new type of reboiler used on the column. A complete physical description of the column is also given. (auth)

48732 (ORNL-IIC-37(Pt.1)) SELECTED ABSTRACTS OF WORLD LITERATURE ON PRODUCTION AND INDUSTRIAL USES OF RADIOISOTOPES. (From NSA January-March 1971). Gerrard, Martha; Baker, P. S. (Oak Ridge National Lab., Tenn.). Jul 1971. Contract W-7405-eng-26. 30p. Dep. NTIS.

Approximately 250 abstracts of domestic and foreign publications on production and use of radioisotopes and radiation, selected from the January to March 1971 issues of Nuclear Science Abstracts, are presented. (auth)

48733 (ORNL-TM-3491) ISOTOPE KILOWATT PROGRAM QUARTERLY PROGRESS REPORT FOR PERIOD ENDING JUNE 30, 1971. Fraas, A. P.; Samuels, G. (Oak Ridge National Lab., Tenn.). Aug 1971. Contract W-7405-eng-26. 20p. Dep. NTIS.

The organic capsule test continued during the quarter without interruption and has accumulated 4370 hr of operation as of the end of June. The design review of the one-quarter scale organic fluid decomposition test loop was completed and the Quality Assurance Program plan was revised. The instrumentation application drawing was approved and drawings showing the electrical and instrumentation control systems were completed. Tests with the glass mockup of the quarter-scale organic test loop demonstrate that the boiler flow stability is excellent even with one boiler tube operating at zero power and the other two at full power. Similarly, tests covering a wide range of other highly unbalanced operating conditions have disclosed no undesirable characteristics. Procurement of hardware for the quarter-scale organic fluid evaluation test loop is underway. The heat block-shield unit has been completed, inspected, and loaded with $SrTiO_3$. Radiation dose rates as a function of position are being determined. Fabrication of the piping has been delayed but will begin in July as soon as the full complement of final approvals have been obtained. Heat pipe tests at ORNL under a wide range of power and attitude conditions indicate peculiarities in the performance characteristics. Several hypotheses that have been advanced to explain all of these peculiarities have been investigated. Nondestructive diagnostic tests to determine the reason for its unusual behavior have included radiographs (which revealed a gas bubble in the lower end of the pipe) and eddy current tests. The results indicate that the anomalous behavior of the heat pipe has been caused by one or more bubbles of a non-condensible gas other than hydrogen (probably argon) trapped between the wick and the outer tube. The potassium will be removed and, after a thorough bake-out, the pipe will be reloaded. The thermoelectric module test was restarted after

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replacing the heaters, but the hermetic seal at the base of the thermoelectric region failed. Tests of the original wire screen thermal insulation indicated that paint on the wire might increase its emissivity, thus increasing its effective thermal conductivity. New wire screen free of paint and with a sharper melting point was procured and tested, but showed no improvement. Thin (.002 in.) sheets of foil of alloy 5052 will be used in an effort to reduce the radiation loss in the next test. All of the components for the heat block-shield test are in various stages of procurement except for the screen insulation and vacuum tank. Delivery of the major item, the heat block-shield assembly, is scheduled for September 1, 1971. Fabrication of the screen and tank will not be started until the screen thermal conductivity values are obtained with the foil. (auth)

48734 (SNC–2708-3) DEVELOPMENT OF THE SIREN CAPSULE. Final Report, Phase IB. Anderson, R. W.; Bierds, W. F.; Rexford, H. E. (Sanders Nuclear Corp., Nashua, N. H.). Dec 1970. Contract AT(29-2)-2708. 54p. Dep. NTIS.

An evaluation of ZrO_2–ZrO_2 composite liner materials and development of hot fabrication methods were performed as part of the development of the SIREN capsule—a non-metallic encapsulation system for radioisotopic heat sources. Of the ZrO_2 materials available for liner applications, the most promising materials were selected for evaluation as ZrO_2–ZrO_2 composite liners. Test ZrO_2–ZrO_2 composite liners were evaluated for gas permeability; thermal stability, and post impact containment of simulated fuel cores (ThO_2–Mo cermet). Methods were developed for filament winding ZrO_2 yarn and graphite yarn over hot fuel cores (thermal fuel simulants). As part of the development of methods for hot infiltration of the graphite impact structure, process parameters were defined for the deposition of pyrolytic carbon. (auth)

48735 (SNC–3693-1) ^{170}Tm OXIDE FOR THERMAL SOURCE APPLICATIONS. Anderson, Robert W.; Nelson, C. A.; Fretague, W. J.; DesChamps, N. H.; Fink, C. R.; Tse, A. (Sanders Nuclear Corp., Nashua, N. H.). 1970. Contract AT(40-1)-3693. 435p. Dep. NTIS.

Research and development directed to development of thulium-170 heat sources are summarized in four parts. A separate abstract was prepared for each part. (J.R.D.)

For abstracts of individual sections see: 48736–48739.

48736 (SNC–3693-1, Pt.1) COMPATIBILITY STUDY OF CONTAINMENT MATERIALS FOR THULIUM OXIDE. Anderson, Robert W. (Sanders Nuclear Corp., Nashua, N. H.). 102p.

In ^{170}Tm oxide for thermal source applications.

The compatibility was determined for Tm_2O_3/Yb_2O_3 with five candidate metallic encapsulant materials; Hastelloy X, Haynes 25, T-111, TZM, and tungsten. Tests were performed on sealed capsules at temperatures of 600, 1000, and 2000°C for times up to 4000 hours. Methods of evaluation included visual and metallographic examination, x-ray diffraction analysis and electron microprobe analysis. It was concluded that Tm_2O_3/Yb_2O_3 can be successfully contained for long periods of time at temperatures up to 2000°C. The demonstrated compatibility of each of the five candidate encapsulant materials allows considerable latitude in application of Tm_2O_3 as an isotopic fuel source. (auth)

48737 (SNC–3693-1, Pt.2) PHASE DIAGRAM DETERMINATION OF THE Tm_2O_3–Yb_2O_3 SYSTEM. Nelson, C. A.; Anderson, R. W.; Fretague, W. J. (Sanders Nuclear Corp., Nashua, N. H.). 74p.

In ^{170}Tm oxide for thermal source applications.

A thermal analysis is presented of the Tm_2O_3/Yb_2O_3 system from ambient temperature to the melting point and over the composition range 100% Tm_2O_3 to 100% Yb_2O_3. A phase diagram is derived which is typical of a solid solution system. Results are supported by x-ray diffraction and metallographic data. High purity NBS aluminum oxide (Al_2O_3) was used to standardize the experimental equipment used in melt point determinations. (auth)

48738 (SNC–3693-1, Pt.3) THULIUM OXIDE FUEL CHARACTERIZATION STUDY (^{170}Tm FUELED CAPSULE PARAMETRIC DESIGN). DesChamps, N. H.; Fink, C. R.; Nelson, C. A. (Sanders Nuclear Corp., Nashua, N. H.). 153p.

In ^{170}Tm oxide for thermal source applications.

An analytical parametric study was made of an infinitely long, cylindrical fuel capsule containing thulia ($Tm_2^{170}O_3$) encapsulated in two different physical forms and in two different liner configurations. Diameters of wafers maintained at 0.060 inch thickness were varied between 0.6 and 3.0 inches. Radial temperature profiles were determined for thulia power densities ranging from 8 to 24 W/cc and fuel capsule surface temperatures ranging from 1000 to 2732°F. Hastelloy-X, Haynes-25, T-222, tungsten, platinum, and molybdenum are the liner materials investigated. Methods of calculation, (including computer codes), assumptions used, error analyses and results are presented and discussed. Recommendations are made with respect to additional studies. (auth)

48739 (SNC–3693-1, Pt.4) ^{170}Tm OXIDE HEAT SOURCE EXPERIMENTAL AND ANALYTICAL RADIATION AND SHIELDING STUDY. Tse, A.; Nelson, C. A. (Sanders Nuclear Corp., Nashua, N. H.). 106p.

In ^{170}Tm oxide for thermal source applications.

Radiation dose rates from three thulium-170 oxide sources (20.7, 10.0 and 5.0 thermal watts) were measured through three thicknesses (¼, ½ and 1 inch) of absorber by thermoluminescent dosimetry techniques. Absorber materials used were aluminum, stainless steel, lead, tungsten, and depleted uranium. Resultant radiation doses were measured at two source-to-dose point separation distances–(19 cm and 100 cm). Comparison of theoretical dose rates calculated by computer with measured dose rates validated the calculation technique for lead, tungsten, and uranium absorbers but not for aluminum and stainless steel. Use of infinite medium build-up factors (B_∞) was thus validated in computation of dose rates for lead, tungsten, and uranium absorbers; use of B in computation of dose rates for aluminum and stainless steel absorbers caused overestimation of the dose rates vis-a-vis experimentally determined dose rates. (auth)

48740 (TID–25752) PROGRAM TO EVALUATE THE EDUCATIONAL USES OF A ^{252}Cf SOURCE IN A NUCLEAR SCIENCE AND ENGINEERING PROGRAM. Annual Report, January–December 1970. Eichholz, Geoffrey G. (Georgia Inst. of Tech., Atlanta. School of Nuclear Engineering). Jan 1971. Contract AT(38-01)-568. 48p. Dep. NTIS.

Activities relating to the use of ^{252}Cf neutron sources at Georgia Institute of Technology are reviewed, including, safety and monitoring procedures, observed and condensed experimental procedures using the californium source that were incorporated into courses at the university. (D.H.M.)

48741 (TID–25769) MAGNETIC FIELD MEASUREMENT AND ANALYSIS. PART 1. SNAP-27 PROGRAM. Final Report. Wouch, Gerald (General Electric Co., Philadelphia, Pa. Missile and Space Div.). 15 Jun 1967. Contract AT(30-1)-3535. 66p. Dep. NTIS.

Results of magnetic field measurements on the radioisotope thermoelectric generator are reported. Measurements were made under conditions such as in earth's ambient field, in zero field environment, depermed in zero field environment, after perming in 15-Oe field, rotating in 0.26-Oe fields, and with selected currents flowing in depermed generators in zero field. (J.R.D.)

48742 PRODUCTION OF A VERY STRONG POSITRON SOURCE ^{58}Co. Doyama, M.; Kuribayashi, K.; Nanao, S.; Tanigawa, S. (Tokyo Univ.). Phys. Lett.; 35A: No. 4, 224-5(14 Jun 1971).

A possible method of producing a very strong, less expensive, and reasonably long-life ^{58}Co positron source is proposed and a preliminary experiment is reported. Pure Ni is irradiated by fast neutrons in an atomic reactor and ^{58}Co is separated. (auth)

48743 GAS SAMPLING DEVICE FOR ULTRACENTRIFUGES. Le Manach, Jean (to Commissariat a l'Energie Atomique). French Patent 2,036,051. 14 Dec 1970. Filed 3 Mar 1969. (In French).

A gas sampling device for ultracentrifuges is presented. This device consists of a cylindrical bowl rotating about an axis, two parallel ends closing the bowl, and a feed pipe for the gas to be centrifuged, which is an extension of the axis. The bowl has a series of gas escape holes at one of its ends. The holes are distributed about the circumference of a circle whose diameter is slightly less than that of the bowl. (France)

48744 VARIOUS PROBLEMS IN INDUSTRIAL DEVELOPMENT OF CENTRIFUGAL SEPARATION METHOD. Takashima, Yooichi (Tokyo Inst. of Tech.). Karyoku Hatsuden; 21: No. 8, 938-45(Aug 1970). (In Japanese).

Industrial enrichment of uranium-235 with centrifugal separators presents many problems. A large-scale project to produce 1000 tons of 5% enriched uranium annually was assumed. About 860,000 centrifugal separators are necessary under ideal conditions of 400 m/sec peripheral speed and 70% separation efficiency. In case of the centrifugal separation, the power requirements are less, construction cost is expensive, separation stage requirement is less, circulating amount of UF_6 gas is less, and

holdup amount of the UF_6 gas is less in comparison with gaseous diffusion process. In the centrifugal separators, ^{238}U and ^{235}U are separated by pressure diffusion due to steep pressure gradient caused by centrifugal force and gas flow due to density difference. Extraction of separated gases is carried out through shafts or perforated end plates. Helium gas is filled between a rotating cylinder and a stationary outer drum to lessen wind loss. Separation of helium is easy because its properties differ from those of the UF_6. Formation of the centrifugal force field to attain 70% efficiency seems not so difficult. At present, aluminum alloys are used for the rotating cylinders, but FRP is very promising. Wilson shaft seals and pivot bearings are used, but studies are necessary for the solution of problems. Cold-trap process is designed for the separation of the UF_6 and helium gas mixture. (Japan)

48745 ASSESSMENT OF ^{169}Yb FOR INDUSTRIAL RADIOGRAPHY. Halmshaw, R.; Manby, T. J. (Royal Armament Research and Development Establishment, Fort Halstead, Eng.). Brit. J. Non-Destruct. Test.; 13: No. 4, 102-5(Jul 1971).

Characteristics of ^{169}Yb are given, including a table of its γ-ray energies with associated relative intensities and internal conversions. The half-life value of 31 days is generally used. Experiments with an enriched ^{169}Yb source, to obtain exposure curves for steel and aluminum, are described which gave half-value thicknesses, for the straight portion of the exposure curve, of 7.5 mm for steel and 24.0 mm for aluminum. Similar exposure curves can be obtained for a natural ^{169}Yb source. ^{169}Yb, ^{192}Ir, and x radiographs are compared for irradiation of steel. It is concluded that ^{169}Yb would extend the thickness range of material which could be examined with γ rays if it were available at a suitable price. (UK)

48746 RADIOISOTOPE THRUSTER TECHNOLOGY. Martinez, John S.; Jackson, Frederick A. (TRW Systems, Redondo Beach, Calif.). pp 166-203 of Aerospace Nuclear Applications Proceedings. Huntsville, Ala.; American Nuclear Society (1970).

From Meeting on aerospace nuclear applications; Huntsville, Ala. (28 Apr 1970). See CONF-700441.

The past five years have seen a progressive evolution in radioisotope thruster technology from the conceptual stage through hardware demonstration. This evolution has been accompanied by a shift in emphasis from high specific impulse (I_{sp}) (700 to 800 sec), continuous thrusting, cryogenic systems for primary propulsion applications to lower I_{sp} (250 to 350 sec), pulsed, storable systems for auxiliary propulsion applications. In recent years, the effort has been concentrated on development of hardware capable of: satisfying the long-term (3 to 5 years) operational requirements of realistic future missions; achieving the operating temperatures needed to deliver the desired I_{sp}; and satisfying all nuclear aerospace safety criteria. Four different concepts have undergone experimental testing: Poodle, a ^{210}Po hydrogen thruster; the gamma-jet, a ^{60}Co hydrogen thruster; the radioisojet, a ^{147}Pm ammonia thruster; and DART, a ^{238}Pu ammonia thruster. The DART, which is most nearly ready for operational use, has operated successfully for more than 18 months. The status of work on these thruster concepts is summarized and the applicability of these thrusters to future missions of interest is discussed. (auth)

48747 ALSEP-SNAP-27 APPLICATION. Pitrolo, A. (General Electric Co., Valley Forge, Pa.); Lewis, L. pp 408-31 of Aerospace Nuclear Applications Proceedings. Huntsville, Ala.; American Nuclear Society (1970).

From Meeting on aerospace nuclear applications; Huntsville, Ala. (28 Apr 1970). See CONF-700441.

The Apollo Lunar Surface Experiment Package (ALSEP), a collection of lunar scientific experiments, utilizes a radioisotope thermoelectric generator (RTG) as its prime power source. The RTG is SNAP-27 which was designed, developed, and fabricated specifically for this mission. A discussion of ALSEP is given describing the various experiments and the typical mission profile from launch to data acquisition. An analysis is given describing the various applicable electrical power supplies considered early in the program which lead to the selection of the SNAP-27. A description of the SNAP-27 system covering each significant component with respect to its design and performance characteristics is also given. Design and verification data both from actual generators and modules are discussed highlighting the programs in-depth testing and verification program. The performance of the first operational system deployed on November 19, 1969 by the Crew of Apollo 12 is described. This system has exceeded earth-based performance prediction by producing in excess of 73 watts. (auth)

48748 SNAP 19 TAGS 85/2N VIKING AND PIONEER APPLICATION. Linkous, Guy F. (Teledyne-Isotopes, Palo Alto, Calif.); Smith, Robert D.; Wilbur, Arthur C. pp 432-65 of Aerospace Nuclear Applications Proceedings. Huntsville, Ala.; American Nuclear Society (1970).

From Meeting on aerospace nuclear applications; Huntsville, Ala. (28 Apr 1970). See CONF-700441.

The SNAP-19 radioisotope thermoelectric generator (RTG) evolved as a result of design and operational experience gained from the SNAP-9A developed by the AEC and subsequently launched aboard Navy/APL Transit satellites. SNAP-19 RTG thermoelectric modules are discussed showing successive improvements in performance and stability. Design characteristics of the SNAP-19 TAGS 85/2N RTG common for the Pioneer spacecraft and Viking Lander are presented. Design requirements, environmental and mission constraints, and integration parameters affecting the SNAP-19/spacecraft interfaces are also discussed. The bases for selection of the SNAP-19 power system for both the Pioneer and Viking Lander interplanetary missions are presented. Life, performance, and reliability characteristics at planetary distances are shown to be vital factors in power system selection. RTG advantages for Pioneer F/G missions over solar arrays are discussed. Observed range of competing solar cell performance at low light intensities is cited in the selection of SNAP-19 to supply necessary Pioneer spacecraft power at Jupiter encounter. SNAP-19's selection for the Viking Lander power system in addition to those advantages cited for Pioneer involved consideration of the need for a rugged self-contained power system in deference to the unknowns associated with Mars surface temperature, winds, atmospheric composition, soil, and topography. (auth)

48749 TRANSIT POWER SUPPLY. Jones, Ian R. (TRW Systems Group, Redondo Beach, Calif.). pp 466-503 of Aerospace Nuclear Applications Proceedings. Huntsville, Ala.; American Nuclear Society (1970).

From Meeting on aerospace nuclear applications; Huntsville, Ala. (28 Apr 1970). See CONF-700441.

The first five-year-lifetime radioisotope thermoelectric generator (RTG) is being developed for the Navy's Transit Navigation Satellite. The RTG is designed to produce 30 watts end-of-life power and will utilize a lightweight, lead telluride thermoelectric converter that provides in excess of 3 watts per pound beginning-of-life power exclusive of the heat source. Since the hot-side thermoelectric temperature is relatively low (~400°C) the converter does not require hermetic sealing, thereby providing increased reliability over higher-temperature systems which require maintenance of an inert cover gas to inhibit thermoelectric material sublimation. The RTG heat source, for the first time, is designed to provide both intact reentry and intact impact capability and is of all-refractory construction. In addition, the $^{238}PuO_2$ fuel will be in the form of a solid solution cermet of plutonium dioxide which is expected to have added safety advantages over the previously used plutonium dioxide microspheres. (auth)

48750 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF HEAVY WATER. Kluge, Hans (to Steinkohlen-Elektrizitaet Aktiengesellschaft). Btisish Patent 1,224,946. 10 Mar 1971. Priority date 6 Jun 1968, Germany.

A method for production of heavy water is described. Waste heat from a reactor is used in a cooling tower saturated with water vapor to carry the vapor into a stripping zone into which the makeup water for the tower is fed. The lower boiling H_2O component is evaporated leaving the water still in circulation enriched in D_2O. This can be drawn off as D_2O-enriched water. (J.R.D.)

48751 METHOD OF PREPARING ^{192}Ir GAMMA-RAY SOURCE OF HIGH SPECIFIC ACTIVITY. Enomoto, Shigemasa; Maeda, Syo (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi; 13: No. 6, 312-17(Jun 1971). (In Japanese).

When preparing ^{192}Ir γ-ray source, there is a serious effect of neutron self-shielding during the irradiation. In order to avoid this effect, thin discs separated from each other were irradiated in capsule and after irradiation, they were piled one against the other to form a cylindrical source. This method should be applicable to the preparation of intense γ-ray sources for radiography. Iridium discs, 0.2 and 0.4 mm thick, were irradiated in the experimental hole of JRR-2, and the ^{192}Ir γ-ray dose from each disc and also of the built-up source was observed. In comparison with a 2mm dia × 2 mm thick source prepared in the conventional way, the γ-ray strength from the built-up source of the same overall size was larger by 2.3 and 1.6 times greater on sources made up of 0.2 and 0.4 mm thick plates, respectively. Furthermore, the built-up source showed better radiographic quality than a conventional source of the same dimensions, its radioactivity being more homogeneously distributed through the source. (auth)

48752 TWENTY-FIVE YEARS OF RADIOISOTOPE DISTRIBUTION AND UTILIZATION. Seaborg, Glenn T. (Atomic

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Energy Commission, Washington, D. C.). Isotop. Radiat. Technol.; 8: No. 4, 373-6 (Summer 1971).

Twenty-five years of progress in the production of radioisotopes and the development of uses of radioisotopes in agriculture, environmental studies, industry, and medicine are reviewed. (L.C.L.)

48753 PRODUCTION OF SYNTHETIC FALLOUT AT CAMP PARKS. Lane, William B. (Stanford Research Inst., Palo Alto, Calif.). Isotop. Radiat. Technol.; 8: No. 4, 408-12 (Summer 1971).

The preparation of sand labeled with $^{140}Ba-^{140}La$ and with ^{90}Y for use in synthetic-fallout studies is described together with the facility where the preparation is made. (auth)

48754 CELL AND TECHNIQUES FOR THE ELECTRODEPOSITION OF INSOLUBLE HYDROXIDES ON THIN METALLIZED PLASTIC FILMS. Bellemare, M.; Roy, J. C. (Univ. Laval, Quebec). Nucl. Instrum. Methods; 96: No. 1, 209-11 (1971).

The method has been applied to the preparation of thin uniform sources of ^{241}Am, ^{233}U, ^{160}Tb, ^{147}Pm and ^{46}Sc. The electrolysis takes place in HNO_3 medium at pH 3 using a total volume of ≈0.2 ml of solution. Yields between 90 and 100% are obtained for 20 min of electrolysis upon adding about 1 μg of carrier. (auth)

48755 LIQUID DIFFUSION CASCADES. Miller, L. (National Chemical Research Lab., Pretoria). Ber. Bunsenges. Phys. Chem.; 75: No. 3-4, 206-7 (Apr 1971).

Experiments were conducted on the diffusion of Li and uranyl salts in polyethylene glycol. The separations were accelerated by substituting nylon gauze for the fritted glass discs and using conical cascades. Some degree of separation ($\alpha - 1 \sim 4.8\%$) was obtained for ^{6}Li and ^{7}Li, but almost no separation occurred for the uranyl nitrate and UCl_4; the lighter isotope ^{235}U was slightly depleted at the bottom of the cascade. (D.L.C.)

48756 STATISTICAL MEASURING ERRORS CAUSED BY RADIATION FILTERS. Schwaar, L. (VEB RFT Messelektronik, Dresden); Schwaar, P. Isotopenpraxis; 6: 482-3 (Dec 1970). (In German).

The effect of filtering materials on radioactivity measurements was analyzed mathematically with respect to energy distribution. The study shows that a Poisson distribution entering a filter material exits again on a Poisson distribution. For practical application, the analysis leads to the conclusion that extremely thin walls are not necessary in sealed sources for obtaining optimal statistical distribution. (H.B.G.)

Materials Testing

Refer also to abstracts 48495, 48705, 48707, 48726, 48732, 48745, 48803, 48816, 48836, 48848, 48852–48855, 48861, 48862, 48873, 48875, 49344, 49545, and 50615.

48757 (AERE-Trans-1120) USE OF NEUTRONS IN RADIOGRAPHY. Diana, M.; di Palo, L.; Giannini, M.; Frazzoli, F.; Ramorino, M. C.; Sciuti, S. Translated by W. G. Stripp (Atomic Energy Research Establishment, Harwell, Eng.), from Com. Naz. Energ. Nucl., Notiz.; 15: No. 4, 46-53 (1969). 17p. Dep. NTIS (U. S. Sales Only). UK 15p.

After reviewing the various techniques used for the application of neutrons to radiographic investigations, results obtained at the Casaccia Nuclear Research Center using the 1 MW (H) RC-1 reactor are reported. These results concern the examination of both objects containing organic compounds and metals, and a natural uranium fuel element. While for the former, neutron radiography must be considered complementary to x-ray radiography, for the latter it can detect defects inside the fuel rod which could not be found by x-ray examination. (UK)

48758 (CEA-CONF-1774) PROBLEMS ENCOUNTERED IN $\beta\gamma$ AND α AUTORADIOGRAPHY OF IRRADIATED MATERIALS. Houdaille, Brigitte; Vignesoult, Nicole; Perrin, Noel (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1971. 26p. (In French). (CONF-710618-2). Dep. NTIS (U.S. Sales Only).

From thirteenth Euratom hot laboratory meeting; Juelich, Germany (24 Jun 1971).

Solutions are given for the various problems (such as the equipment, the various types of emulsions used, and the choice of the exposure time) encountered in the β, γ, and α autoradiography of irradiated samples (UO_2-type fuels; graphite cans) and the alpha autoradiography of Mg–Zr fuel cans. The qualitative use of β autoradiography with oxide-type fuels allows the fission product distribution to be determined in an irradiated fuel with high specific burnup and at high temperature. Quantitative analysis of alpha autoradiographs allowed curves of the Cu diffusion in irradiated fuel cans to be plotted. (France)

48759 (CONF-710402–(Vol.3), pp IV.47-54) OPTIMIZATION OF SOURCE-COLLIMATOR GEOMETRY FOR A NEUTRON RADIOGRAPHIC FACILITY UTILIZING A ^{252}Cf SOURCE. Kok, Kenneth D.; Ray, Joseph W. (Battelle Memorial Inst., Columbus, Ohio).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

The optimization of a neutron radiographic facility requires the maximum possible resolution on the radiograph for the shortest possible exposure. These effects are functions both of the collimator source geometry and the detector-recorder combinations. Several source-collimator geometries were studied utilizing a single detector-recorder combination. The BMI ^{252}Cf neutron radiographic facility allows both horizontal and vertical movement of the neutron collimator with respect to the source. Experimental runs were made utilizing collimators with 7.5 inch and 15 inch lengths and 15:1 length to diameter ratios to determine the peak thermal flux at the collimator inlet, the thermal flux at the collimator outlet, and the gamma dose rate at the collimator outlet. Air gaps were then added to the collimator so that the source was farther from the collimator inlet with little addition of moderating material, thus increasing the neutron-to-gamma ratio at the exit aperture. Optimum source-collimator geometries can be selected using these data to either maximize the flux or the neutron-to-gamma ratio, depending on the particular radiographic application. (auth)

48760 (CONF-710402–(Vol.3), pp IV.55-68) NEUTRON RADIOGRAPHY USING ^{252}Cf FOR AIRCRAFT NDT APPLICATIONS. Dungan, Warren E. (General Dynamics Corp., Fort Worth, Tex. Convair Aerospace Div.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

Neutron radiography research using a 1 milligram californium-252 isotope in a water-moderated tank facility is described. The research was conducted to determine the suitability of using californium-252 for the radiographic inspection of a variety of aerospace materials and components. Conventional direct-exposure techniques using x-ray film with gadolinium metal conversion screens in spring-loaded cassettes were used to obtain several 5 in. by 7 in. neutron radiographs of several items. Image quality indicators, defective pyrotechnic devices, rubber O-rings in sealed metallic valves, boron-fiber laminates, water droplets and sealants in honeycomb structure, and adhesive bonded metallic lap-shear specimens were inspected with varying degrees of success using a 5-in. square beam of thermal neutrons. Detailed measurements of field distributions were made to arrive at suitable shield configurations and beam geometries. Estimates of facilities and shipping costs are given. Thirteen illustrations include sketches of the shipping container and neutron radiography facility, plots of thermal-neutron flux profiles, exposure times for film, film-density grids, and several positive prints of neutron radiographs. It is concluded from the results presented that californium-252 is suitable for the design and fabrication of an inexpensive, cheaply operated facility for exploratory nondestructive test applications of many products using thermal-neutron radiography. (auth)

48761 (CONF-710402–(Vol.3), pp IV.69-77) NEUTRON RADIOGRAPHY WITH ^{252}Cf: THE EFFECT OF TAILORING NEUTRON ENERGY SPECTRA ON PHOTOGRAPHY IMAGES. Bouchey, Gary Don; Draper, E. Linn Jr.; Gage, Stephen J. (Texas Univ., Austin. Nuclear Reactor Lab.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

A californium-252 neutron source was used to study the effects of neutron energy spectrum, converter screen, and film type on the quality of neutron radiographs of a multielement test object. Each of four spectra was investigated with four converter screens. The neutron energy spectrum and gamma content of the beam were altered by filter insertion to enhance imaging of various portions of the test object. (auth)

48762 (CONF-710402–(Vol.3), pp IV.78-86) NEUTRON RADIOGRAPHY WITH A TRIGA NEUTROVISION SYSTEM. Schnurer, George T.; McMain, Albert T. (Gulf Energy and Environmental Systems, Inc., San Diego, Calif.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

The TRIGA NEUTROVISION concept is reviewed, and various types of TRIGA NEUTROVISION systems are discussed. Specific information is given on a low-cost, simplified system, which has great potential for industrial neutron radiography applications. Examples of neutron radiography applications with a TRIGA system are presented. Facility housing, auxiliary equipment, staffing, and maintenance requirements are also reviewed. (auth)

48763 (CONF-710402-(Vol.3), pp IV.86-93) SMALL PULSED REACTOR FOR NEUTRON RADIOGRAPHY, AND UNDERWATER FACILITY USING EXISTING POOL REACTORS. Farny, Gerard; Houelle, Michel (Commissariat a l'Energie Atomique, Paris (France)).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

A very simple inexpensive reactor neutron source has been developed for particular neutron radiography applications. The reactor is based on a solution of uranyl nitrate which is rendered momentarily critical on inward movement of a BeO reflector face, and which then shuts itself down by inherent negative reactivity coefficients. Experimental work has been performed on such an assembly built at the Service d'Etudes de Criticite, and a second assembly built at Cadarache for neutron radiography in the Rapsodie fast reactor program has been in operation for a few months. For this second facility some characteristics are: 2.2 kg ^{235}U critical mass, 93 percent enriched fuel, 2.7 seconds doubling time for 60 grams ^{235}U super criticality. At the exposure peak the power corresponds to 10^{15} fissions per second (30 kW) (5×10^{16} fissions per pulse). Repetition time is 3 hours and for the application of central void examination in fast reactor fuel a collimation ratio of 1:40 gives satisfactory results (3×10^{9} n/cm^2 on indium converter). The seven pool reactors of the CEA in France are now equipped with facilities for underwater neutron radiography. The facilities are proving extremely valuable for frequent inspection and measurement on experiments irradiated within the reactors. A typical facility is described which has a divergent collimator of boron carbide, a variable collimation ratio, a field of view of 60 cm vertical dimension, and can accept objects of complex shape by virtue of an ice sealed exposure system. Such facilities are somewhat complex to develop but are simple and reliable in operation. (auth)

48764 (CONF-710801-(Vol.1), pp 138-65) RECENT DEVELOPMENTS IN NONDESTRUCTIVE EVALUATION APPLICABLE TO ENCAPSULATED ISOTOPES. Newman, Dennis R.; Crowe, James C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

Nondestructive evaluation (NDE) techniques have been applied recently at Battelle-Northwest to primary containers and capsules of radioisotopes to ensure the highest possible integrity of these containers. New techniques have been developed in the ultrasonic and acoustic emission areas. These techniques, along with a philosophy of bringing the NDE personnel into the design of the container before the design is finalized so he can suggest how to make the design "testable," have proven to be an important asset in maintaining container integrity. (auth)

48765 (ORNL-4693) SECOND ANNUAL PROGRESS REPORT ON STUDIES IN APPLIED SOLID MECHANICS (NUCLEAR SAFETY). (Oak Ridge National Lab., Tenn.). Jul 1971. Contract W-7405-eng-26. 73p. Dep. NTIS.

Activities during calendar year 1970 in programs for developing structural design technology for piping components and for attachments of nozzles to pressure vessels are summarized. Both theoretical and experimental efforts are under way to develop improved design methods for assuring, on a practical level, the structural integrity of pressure vessels and primary coolant systems of nuclear power plants. Applications of the technology developed are not limited, however, to nuclear reactor systems. Through these programs, experimental data on structural behavior are being obtained and experimentally proven methods of design analysis established. Design rules and analytical procedures for incorporation into current industry-developed standards and USAEC Division of Reactor Development and Technology (RDT) supplemental standards are also derived. Discussions of piping and nozzle developments are included. (auth)

48766 (ORNL-TM-3300, pp 170-3) NONDESTRUCTIVE TESTING TECHNIQUES FOR LMFBR. Harms, W. O.; McClung, R. W. (Oak Ridge National Lab., Tenn.).

In Fuels and materials development program.

New components were designed and assembled for the eddy-current instrument to measure both size and depth of flaws. Several ultrasonic techniques and the schlieren system are being used to evaluate sample welds that contain intentional flaws. Several improvements with multiple sensors and diffraction techniques are being studied. The stability of the eddy-current instrument that is being developed to measure cold work in stainless steel tubing was improved. The cold work in rods prepared by Argonne National Laboratory is being measured. A new configuration of coils is being studied to reduce the effect of some of the variables. (auth)

48767 (ORNL-TM-3300, pp 304-12) NONDESTRUCTIVE TESTING. Harms, W. O.; McClung, R. W. (Oak Ridge National Lab., Tenn.).

In Fuels and materials development program.

The variations in electromagnetic induction caused by several second-order effects are being analyzed to improve the accuracy of impedance measurements. A computer program shows promise of being usable in calculating both electrical conductivity and lift-off from a single value of impedance. In studies of the measurement of thickness by means of phase-sensing, it was discovered that a coil can be designed that exhibits minimum effect due to variations in lift-off at the same operating conditions which produce maximum response to changes in thickness. Results of flaw size and orientation measurements by ultrasonic frequency analysis of a specimen containing machined flaws were shown to be superior to those made with conventional amplitude techniques. Results of measurement of induced fluorescent x rays from the U dispersed in the core of a fuel plate showed a relationship between detected radiation and thickness of the Al cladding. The noise in the closed-circuit television system is being studied as part of a high-speed high-resolution densitometer. Neutral density filters will be used as part of the calibration. (auth)

48768 (ORNL-TM-3416, pp 148-9) NONDESTRUCTIVE TESTING TECHNIQUES FOR LMFBR. (Oak Ridge National Lab., Tenn.).

In fuels and materials development program quarterly progress report for period ending March 31, 1971.

In the development of the eddy-current instrument for identification of flaws, construction on the two-frequency oscillator and power amplifier module was completed and eleven tuned amplifiers covering a frequency range from 1 KHz to 2 MHz were constructed. Difficulty has been encountered in ultrasonically identifying the reference flaws in the stainless steel welds when using the Delta configuration. Two new designs of coil systems are being studied for the eddy-current measurement of cold work in fuel element cladding. Bifilar-wound coils exhibit greater sensitivity to changes in permeability but have more drift than a side-by-side array. Other benefits of the side-by-side configuration include ease of fabrication and decreased problems with thermal expansion. (auth)

48769 (ORNL-TM-3416, pp 232-8) NONDESTRUCTIVE TESTING. (Oak Ridge National Lab., Tenn.).

In fuels and materials development program quarterly progress report for period ending March 31, 1971.

Computer programs were written for determining both magnitude and phase of impedance for a reflection coil above single and multiple layers of conductors. Standards for conductivity measurements are being prepared. In studies on measuring the thickness of one material clad on another, the criteria for design of coils was developed for maximum sensitivity to clad thickness with an attendant minimum response to changes in coil-to-specimen spacing. A dual gate system has been developed for performing frequency analysis on different portions of an ultrasonic pulse. This improves the capability to measure accurately the size of irregular flaws. The optical equipment for viewing ultrasound is being moved to a new facility and modified to allow studies of Bragg diffraction and volume holography as well as schlieren techniques. EDM notches were made in a tube and subsequently used successfully as an ultrasonic reference standard after the tube had been filled with powder and swaged into a rod. X-ray scattering and fluorescent studies are being converted to the use of a high intensity x-ray source and mechanical scanning system to permit dynamic measurements. Crystal monochromaters are being investigated to minimize the total amount of radiation on the specimen. Optical magnification of the radiographic image is being studied to minimize the relative effect of jitter in the video system for radiographic interpretation. A conceptual design has been completed for installation of a ^{252}Cf source in the laboratory. (auth)

48770 (RFP-Trans-79) HISTORY OF THE ACOUSTIC EMISSION METHOD: A NEW TOOL FOR NDT. Isono, Eiji. Translated for Dow Chemical Co., Golden, Colo., from Hihakai Kensa; No. 11, 579-985(1970). 32p. Dep. NTIS.

A history of the acoustic emission method is presented and use of the method for monitoring pressure tests for a missile

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fuel tank or a nuclear pressure vessel, studying destructive mechanisms (plastic deformation, brittle fracture, fatigue, corrosion stress cracks, etc.) and studying or monitoring weld cracks are also discussed. (D.H.M.)

48771 INTERPRETING WELD RADIOGRAPHS. Chuse, Robert. Weld. Eng.; 56: No. 6, 39-41(Jun 1971).

A discussion is given of the problems encountered in interpreting x-ray and gamma-ray radiographs correctly. The correct use of penetrameters for the required thickness and sensitivity is described. The questions to ask when interpreting a radiograph are given. The use of stereoscopic radiography to determine the depth of the defect is suggested. The standards for accepting or rejecting welds are discussed. Finally, the conditions for viewing the film and detecting almost-invisible defects are discussed. (D.L.C.)

Protective Structures

Refer also to abstract 49955.

48772 (JAB-99-50) CONCRETE TEST STRUCTURES: SECOND PROGRESS REPORT ON STRUCTURAL RESPONSE. Freeman, Sigmund A. (Blume (John A.) and Associates Research Div., San Francisco, Calif.). Jul 1971. Contract AT(26-1)-99. 153p. Dep. NTIS.

The results of a second group of field tests performed to determine the structural response characteristics of two identical four-story reinforced concrete test structures located in Area 1 of the Nevada Test Site are presented. During the period covered, several changes were made in the partition content of the test structures. The content refers to the materials used in constructing the partitions, e.g., gypsum wallboard. Concrete block was installed, plastered, and later removed from the south structure. In the north structure gypsum wallboard partitions were removed and replaced later by hollow clay tile. Instrumentation included the use of L-7 velocity recorders. Test results are presented by curves showing natural periods of vibration and damping values in relationship to roof level displacements. The four-story test structures have exhibited pronounced changes in period and damping because of installation and removal of partitions. Exposure to strong ground motion had a substantial effect on the participation of the partitions. (auth)

Radioactive Material Handling

Refer also to abstracts 48602, 48604, 48727, 48760, 48764, 48952, 50591, 50613, and 51229.

48773 (ARH-2029) WELDING DEVELOPMENT FOR THE WASTE ENCAPSULATION PROGRAM. Interim Report No. 4. Wormeli, J. C. (Atlantic Richfield Hanford Co., Richland, Wash.). 6 Apr 1971. 26p. Dep. NTIS.

Welding and testing operations associated with remote encapsulation of radioisotopes are described. Information is included on nondestructive testing, capsule design, welding processes, and capsule evaluation. (J.R.D.)

48774 (ARH-SA-98) ESTABLISHING A FAVORABLE SAFEGUARDS CLIMATE WITHIN A NUCLEAR FACILITY. Colvin, Curtis A.; Shepard, Donald F. (Atlantic Richfield Hanford Co., Richland, Wash. Separations Chemistry Lab.). 8 Jun 1971. Contract AT(45-1)-2130. 15p. (CONF-710617-4). Dep. NTIS.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

Efforts toward developing an effective safeguards program involve not only research and development, but also the effective application of known technology by resourceful humans. The following areas of attention are presented with humanistic as well as procedural aspects being discussed: gaining the understanding and concern of those involved as to the importance and worth of safeguards efforts; the role and qualifications of a statistician responsible for practical application of statistics to safeguards; and elements involved in the acquisition of data through laboratory standards and referee programs in order to achieve normality and constancy of variance. Practical experience is cited when applicable. (auth)

48775 (BNWL-SA-3929) SAFEGUARDS VALUE OF ISOTOPIC CORRELATIONS. Schneider, R. A.; Stewart, K. B.; Christensen, D. E.; Prezbindowski, D. L. (Battelle Pacific Northwest Labs., Richland, Wash.). 18 Jun 1971. 40p. (CONF-710617-27). Dep. NTIS.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

A broad experimental and theoretical base has been established for safeguards applications of isotopic correlation techniques. It is now possible to illustrate more clearly potential applications of the concept and also to define more exactly its quantitative aspects and limitations. The potential safeguards uses of the isotopic correlation technique are discussed in some detail. Safeguards value is illustrated for three separate users, i.e., a central safeguards agency, a reactor operator, and a chemical processing plant operator, and for four separate objectives including: verification of the Pu content of spent fuel; confirmation of previous safeguards information; cross-checking of analytical measurements made on dissolver solutions; and improvement of the theoretical base for reactor calculations. Each application is illustrated with experimental data. Also, the statistical and theoretical basis for the applications is included when appropriate. (auth)

48776 (CONF-710402-(Vol.2), pp I,61-71) MOBILE ACCELERATOR FACILITY FOR NEUTRON INTERROGATION AND NONDESTRUCTIVE ASSAY. Dennis, Bert R.; Forster, R. A.; Menzel, J. H.; Thorpe, M. M.; Smith, D. B. (Los Alamos Scientific Lab., N. Mex.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

The Mobile Nondestructive Assay Laboratory (MONAL) employed by the Nuclear Safeguards Research Group at Los Alamos utilizes a 200-kV positive-ion accelerator for active neutron interrogation and assay of fissionable materials. The accelerator produces neutrons by the $D + T \rightarrow n + {}^4He$ reaction and is operated in a pulsed or modulated mode. Addition of a post-acceleration beam-deflection system ensures a large neutron source "on-to-off" ratio. The accelerator was designed for operation specifically in the MONAL, and procedures were developed for fast efficient transshipment of the entire mobile laboratory, including accelerator, between deployment locations. An integral part of the active neutron interrogation system in the MONAL is the necessary personnel shielding surrounding the interrogation chamber; the main neutron shield consists of refillable water tanks, which are drained prior to transit. Shield design characteristics and neutron flux distributions in the interrogation chamber were investigated using three-dimensional Monte Carlo calculations. Similar calculations were made on spectrum-tailoring assemblies for appropriately moderating and reflecting the 14-MeV source neutrons. These calculations, plus supporting measurements, provide guidance in the development of active interrogation methods for nondestructive assay of fissionable materials using the MONAL facility. (auth)

48777 (CONF-710617-1) NUCLEAR MATERIALS CONTROL SYSTEM IN A MULTI-ENRICHMENT PROCESSING PLANT. Collopy, T. J. (United Nuclear Corp., [Elmsford, N. Y.]). 5 Jun 1971. 19p.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

The nuclear materials control system currently used within the Hematite, Mo. Plant of the United Nuclear Corp. is discussed. The Hematite operation is primarily concerned with the conversion of enriched UF_6 to a variety of U compounds. Each of five material balance areas is described as to physical arrangement, typical inventory level, and control procedures used. Programs for taking monthly inventories and for improving effluent control and monitoring, both of which result in lowering the total loss assigned to materials unaccounted for, are mentioned. (L.C.L.)

48778 (CONF-710617-2) RECOMMENDED APPLICATIONS OF NUCLEAR SAFEGUARDS TO THE STORAGE OF MATERIALS IN THE PROPOSED NATIONAL NUCLEAR WASTE REPOSITORY, LYONS, KANSAS. Chezem, C. G.; Krick, M. S.; Meyer, W. (Kansas State Univ., Manhattan. Dept. of Nuclear Engineering). Jun 1971. 13p. Dep. NTIS.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

A salt mine at Lyons, Kansas has been selected for the storage of radioactive wastes. Two types of waste will be stored, low-level alpha-contaminated waste from nuclear weapons production and Plowshare applications, and high-level wastes from the nuclear powered electric utility industry. Public concern about the safety of the waste storage facility is described. Methods for high-level waste containment and storage are discussed. The potential hazards to the public, particularly from possible contamination of ground waters passing through the storage site, are described. Safeguards and accounting procedures for verifying the amount of fissionable material received for deposit in the mine are recommended. (L.C.L.)

48779 (CONF-710617-3) FIELD EXPERIENCE WITH THE AEC MEASUREMENT VAN. Cohen, I.; Gundersen, G. (Division

of Nuclear Materials Safeguards (AEC), Washington, D. C.). [nd]. 23p. Dep. NTIS.

From twelfth annual meeting of the nuclear materials management; West Palm Beach. Fla. (29 Jun 1971).

Nuclear materials safeguards inspections by the District I Safeguards Office include independent tests of the licensee's physical inventory. The Division of Nuclear Materials Safeguards District I Office personnel have performed on site measurements of items of inventories using a mobile computerized multi-channel gamma spectrometer at different types of facilities during the early months of 1971. The equipment, field tests performed, and capabilities are discussed. (auth)

48780 (CONF-710617–5) [SAFEGUARDS PROGRAM]. Crowson, Delmar L. (Office of Safeguards and Materials Management (AEC), Washington, D. C.). [nd]. 17p. Dep. NTIS.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

The goal of the USAEC domestic safeguards program is to prevent the theft of nuclear materials. The objective of the IAEA safeguards system is to prevent the proliferation of nuclear weapons to states not now possessing such weapons. The IAEA safeguards are designed to detect nuclear materials diversion whereas the domestic US safeguards program is concerned with preventing such diversion. Current research and development programs for performing material inventories, for improving measuring methods, and for decreasing the limit of error of Materials Unaccounted For are discussed. It is recommended that industry increase its efforts in materials accounting using already developed safeguards procedures and instruments, and that regulations for the performance of various components in accounting systems be rigorously enforced. (L.C.L.)

48781 (CONF-710617–6) NUCLEAR MATERIALS SAFEGUARDS: A UTILITY VIEWPOINT. Diesk, R. R. (Commonwealth Edison Co., Chicago, Ill.). 1971. 7p.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

The experience of the Commonwealth Edison Co. in safeguarding nuclear materials used to fuel its nuclear power plants is discussed. Electric utility companies involved with nuclear power are interested in the development of an effective safeguards system achieved at a minimum cost. Specific suggestions for achieving this include: evaluating the diversion potential at each step in the fuel cycle and tailoring the safeguards requirements at each step to the diversion threat; simplification of overlapping or duplicating surveillance efforts, e.g., those of the IAEA, USAEC, and commercial companies; revision of current material balance and sampling equipment and techniques to obtain greater efficiency with less interruption of the fuel cycle processes; and, apart from instrumentation development, more research in designing security systems for the transport of nuclear materials, information systems, and alarm systems. (L.C.L.)

48782 (CONF-710617–8) A REVIEW OF THE DEPARTMENT OF TRANSPORTATION (DOT) REGULATIONS FOR TRANSPORTATION OF RADIOACTIVE MATERIALS. Grella, Alfred W. (Department of Transportation, Washington, D. C.). [1971]. 41p.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

The US Department of Transportation regulations for the safe transport of radioactive materials, published each January as Title 49, Code of Federal Regulations, Parts 1 to 199, are reviewed. These regulations cover: air, land, and sea transport; the type, quantity, and form of radioactive material shipped; packaging requirements; control of radiation during transport; package and vehicle labeling; closure and sealing devices; criticality safety; temperature limitations; package test requirements; and shipper and carrier responsibilities. DOT and IAEA regulations are compared and differences between these are noted. (L.C.L.)

48783 (CONF-710617–9) CALCULATED INVENTORY DIFFERENCES: A POTENTIAL SAFEGUARDS AND MATERIAL CONTROL TECHNIQUE. Hagie, L. T.; Wadekamper, D. C.; Marcuse, W. (General Electric Co., Pleasanton, Calif.). [1970]. Contract AT(30-1)-68. 26p. Dep. NTIS.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

The use of calculated inventory differences as a potential material control measure has been tested as part of the Integrated Safeguards Experiment. During the fabrication of 48 mixed oxide (urania and plutonia) fuel rods material balances around individual process stations were calculated based on weights of materials transferred in and out of the system. Since the fabrication program was conducted in a series of process campaigns for individual fuel enrichments, it was possible to clean all processing equipment between enrichment levels and calculate material balances for each process station. The amount of material calculated to be remaining in the individual process stations after the between-enrichment clean-outs is termed the calculated inventory difference. The oxide weight of material transferred in and out of each process station was used for one set of material balance calculations, while the "SS weight" (metal weight of material after correcting for oxygen and moisture) was used for a second set. The resulting calculated inventory differences for individual process stations were –0.6 to 2.1% for oxide and –0.6 to 1.0% for metal (uranium plus plutonium). The sum of the calculated inventory differences was consistent with the overall balances obtained for the fabrication line. A total throughput of 139.9 kg of oxide (or 121.1 kg metal) was processed during the test. While the calculated inventory differences were observed to vary greatly from process station to process station, they were reasonably consistent for individual process stations over several process batches. Thus, routine calculation of material balances based on weight offers the fuel fabricator a potentially useful tool for monitoring his materials accountability system and detecting unusual losses or diversion in a timely manner. (auth)

48784 (CONF-710617–11) ARGONNE SAFEGUARDS TRAINING PROGRAM: A THREE YEAR HISTORY. Kanter, Manuel A. (Argonne National Lab., Ill.). [nd]. 8p. Dep. NTIS.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

During its first three years of operation the Argonne Safeguards Training Program has offered training in nuclear materials safeguards to over 200 participants from government and industry both foreign and domestic. Its offerings have ranged from a basic course intended for those who are new to the field to specialized workshops for the experienced practitioners. In addition a beginning has been made in the teaching of safeguards and nuclear materials control in existing institutions of higher learning. Developing trends will be assessed as to their effect on future training programs. (auth)

48785 (CONF-710617–12) GENERATION OF A MEASUREMENT CATALOG FOR SAFEGUARDS. Suda, S. C.; Marcuse, W. (Brookhaven National Lab., Upton, N. Y.); Kull, L. A. (JRB Associates, Inc., La Jolla, Calif.). [nd]. 11p. Dep. NTIS.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

The operator of a fuel fabrication plant needs to keep abreast of new developments in chemical analysis and nondestructive assay equipment and methods for making safeguards measurements. In view of the wide variety of methods available, the limitations of methods for particular measurements, and the problems associated with implementing the techniques, a catalog of measurement techniques and data is suggested to aid operators in selecting methods most advantageous to their needs. The proposed format for such a measurement catalog and an example of the cataloguing of data for a particular instrument and method are presented. (L.C.L.)

48786 (CONF-710617–13) FEASIBILITY TESTS OF A COMMERCIAL RADIOGRAPHIC LINAC FOR NUCLEAR MATERIALS ASSAY. Kull, L. A.; Reynolds, G. M. (JRB Associates, Inc., La Jolla, Calif.); Wattacamps, E. (Gesellschaft fuer Kernforschung m,b,H., Karlsruhe (West Germany)); Weinstock, E. (Brookhaven National Lab., Upton, N. Y.). [1970]. 28p. Dep. NTIS.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

Tests were made on a variable energy, standing-wave radiographic electron linac to determine the feasibility of using commercially available electron linacs for nondestructive assays of special nuclear materials. Assay techniques similar to those developed in safeguards research were used to test the linac parameters that are important for nondestructive measurements. The following test results were obtained. The neutron yield/dose for a nuclear materials assay system employing a side coupled standing wave linac without a magnetic analysis system, is stable to within 2% at the lower end of the range of useful assay energies and to within 1% at the upper end. Assays separated by beam-off periods (during which samples can be exchanged) and by electron energy changes are reproducible to within 2%, for the lower (upper) end of this same energy range. Day to day reproducibility of the yield is significantly less; however, the operating point of the system changes by less than 50 keV from one day's operation to the next. These figures show the system to be useful for most assay applications. The linac tested was simple to operate and was interlocked for radiation hazard safety. The times required to make major changes in the linac's operating mode are negligible. Energy changes are especially simple and quick to make when using any one of three pre-selected operational modes. This feature is valuable for

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applications which require only a few operational modes. Research applications which require a continuously variable energy and current must make additional fine internal adjustments after selecting a basic mode near the desired operating point. Analyzing magnet systems are not required for stability and reproducibility. Unlike traveling wave linac systems, the entire electron beam can be utilized for assay purposes. However, systems which are used to assay a large variety of sample configurations (such as mobile assay units or research facilities) should have a simple magnet system to determine the beam energy. This will allow rapid set-up of the system for new types of samples and also save time during research in which one is trying to determine optimum operating points for different types of samples. (L.C.L.)

48787 (CONF-710617–14) UNIVERSITY-BASED PSYCHO-LOGICAL-SCIENTIFIC-POLITICAL ANALYSIS OF SAFEGUARDS. Leachman, R. B.; Brady, D. W. (Kansas State Univ., Manhattan). [1970]. 9p.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

The plan of a research program for studying the human factors in safeguards systems is outlined. These human factors include: the attitudes and concerns held by persons involved in nuclear materials management and the effects of these attitudes on monitoring effectiveness; the typologies of persons likely to divert nuclear materials; and the political processes by which nations come to nuclear agreements. In order to evaluate the human factors, some data on MUF in a fuel fabrication facility were analyzed. (L.C.L.)

48788 (CONF-710617–17) PRACTICAL APPLICATION OF A NON-DESTRUCTIVE URANIUM ASSAY DEVICE. McClanahan, H. H. (Babcock and Wilcox Co., Lynchburg, Va.). [nd]. 46p.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

The assembly, calibration, operation, and accuracy of a non-destructive uranium assay device are described. The device detects gamma rays emitted from uranium scrap contained in drums and cans of various sizes The form of the scrap ranges from liquid waste in 55-gal drums to solid waste, such as floor sweepings and machine turnings, in small 1-gal cans. The personnel who designed the device patterned it (both mechanically and electronically) after similar equipment used at various government laboratories. The data clearly indicates that the technique is best suited for determining the ^{235}U content of homogeneous liquid solutions, and that the accuracy of determining the ^{235}U content of solid waste configurations is limited. (L.C.L.)

48789 (CONF-710617–18) REVIEW OF PROCEDURES FOR SAFEGUARDING AND ACCOUNTING FOR SPECIAL NUCLEAR MATERIALS. Meier, W. C. (Price Waterhouse and Co., New York). [nd]. 9p.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

The activities of a team of certified public accountants that reviewed the procedures for safeguarding and accounting for special nuclear materials are described. Essentially the review entailed: evaluating the overall procedures, both administrative and technical, for accounting for materials received, stored, in-process, and shipped-out; verification that records kept at each of these steps were accurate and complete; and observation of the annual physical inventory for safeguards purposes. The CPA team dealt only with the overall inventories of fissionable material. An AEC audit team was concerned with the U content within the material. It was concluded that, at the time of the audit, the facility investigated had a physical inventory which was accurately reported. (L.C.L.)

48790 (CONF-710617–20) RESULTS OF TYPICAL NON-DESTRUCTIVE MEASUREMENTS OF FISSIONABLE MATERIAL IN VARIOUS FORMS USING NNC MACHINES. Miller, Herman; Shea, Thomas (National Nuclear Corp., Palo Alto, Calif.). [nd]. 23p.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

Practical and simple machines using small, safe, isotopic neutron sources now being used in production facilities for non-destructive fuel assay of materials in various forms from liquids to fuel rods are described. This assay information is used to meet quality control, accountability, criticality and safeguards requirements. The precision of these measurements ranges from better than ±1% for carefully controlled powder samples or rods to ±5% for five gal powder drums and to lower precision for ill-defined scrap assays. Production rod assay machines which provide accurate measurements of the total fissile content of rods are now in routine use. The rods are automatically fed through the machine at a rate of one rod per minute. The same machine can be used at slower speeds to detect single misplaced pellets. Work is continuing on improvements and other applications: As one illustration, the newest fuel rod assay machine has improved counting statistics by a factor of 20 over our earlier machines at speeds of one ft/min, without resort to larger neutron sources. This allows simultaneous search for single 30% high pellets and determination of total fissile material to less than ±1%. Continued use and development of these machines has demonstrated expanded applications, increased speed, and improved measurement accuracy. (auth)

48791 (CONF-710617–21) THE IMPACT OF THE NPT SAFEGUARDS AGREEMENT ON THE SAFEGUARDS OPERATIONS OF THE IAEA. Nakicenovic, Slobodan (International Atomic Energy Agency, Vienna (Austria). Div. of Operations). Jun 1971. 15p.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

The safeguards operations of the IAEA have grown in accordance with the increased number of nuclear research facilities and nuclear power plants in the member countries. The development of these safeguards operations, the procedures used for accounting, controlling, and inspecting nuclear materials, the manpower requirements, costs, and, particularly, the effects of the Nonproliferation Treaty safeguards agreement on each of these aspects of the IAEA safeguards program are discussed. (L.C.L.)

48792 (CONF-710617–23) NEEDED IMPROVEMENTS IN SNM ACCOUNTING AND MEASUREMENT SYSTEMS FOR SAFEGUARDS. Ong, L. D. Y. (Division of Nuclear Materials Safeguards (AEC), Washington, D. C.). [nd]. 19p. Dep. NTIS.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

The inadequacies of current industrial practices for performing physical inventories on nuclear materials are discussed. In order to strengthen the AEC safeguards program it is recommended that: inventories should be conducted more frequently; MUF should be evaluated on a cumulative basis to increase the probability of diversion detection; limits of error in methods for detecting significant MUF's should be reduced and these limits should be more accurately specified; separate materials balances should be maintained for in-process and static material; and the quality of measurements should be improved. (L.C.L.)

48793 (CONF-710617–28) INTERNATIONAL SAFEGUARDS AND DOMESTIC SAFEGUARDS UNDER THE PRESIDENT'S OFFER. Mahy, John F. Jr. (Office of Safeguards and Materials Management (AEC), Washington, D. C.). [nd]. 15p. Dep. NTIS.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

With the time approaching when the IAEA may be applying safeguards in the United States under the President's offer, it is important to be aware of the background and status of the offer. Although many details of how the offer will be implemented have not been settled, several aspects appear to be firming up. These have been discussed during informal meetings with industry which have provided useful exchanges of views as to concerns and expectations about the interface between the two systems as they may be applied in the United States. For example, it is recognized that while duplication of effort should be minimized, some degree of independence of the two systems must be preserved. This and other aspects of the interface will be explored. (auth)

48794 (CONF-710617–29) LIMIT OF ERROR CALCULATIONS USED IN INTEGRATED SAFEGUARDS EXPERIMENT. Smith, Charles N. (National Bureau of Standards, [Washington, D. C.]). [nd]. Contract AT(49-2)-1165. 14p. Dep. NTIS.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

The Integrated Safeguards Experiment relied heavily on nondestructive assay techniques to attain a measured material balance on the mixed oxide fabrication process. The calculations involved in determining the limit of error values for material measurements using calorimetry and neutron coincidence counting techniques as well as conventional chemical assay methods are described. (auth)

48795 (CONF-710617–30) REMARKS AT INSTITUTE OF NUCLEAR MATERIALS MANAGEMENT. Thornton, C. D. W. (Division of Nuclear Materials Safeguards (AEC), Washington, D. C.). [1971]. 14p.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

It is asserted that far too few safeguards measurements are

being made and of too poor a quality and at too high costs, to assure the American public of effective stewardship over nuclear materials. Research and development must be undertaken also by industry and that done by the AEC must be far better conceived and applied. Imputed charge criteria for top management evaluation of nuclear plant managers are proposed to motivate industrial safeguarding. Nuclear Materials Managers should also be performance rated. Much more standard setting should be undertaken by the AEC. Costs of safeguards should be recognized in fully pricing nuclear electricity. Regulatory safeguards enforcement plans are outlined. (auth)

48796 (CONF-710617–31) ACTIVE ASSAY OF FISSIONABLE MATERIALS AT THE LOS ALAMOS NONDESTRUCTIVE ASSAY AND STANDARDS LABORATORY. Thorpe, M. M.; Augustson, R. H.; Menzel, J. H.; Evans, A. E.; Smith, D. B.; Weisbin, C. R. (Los Alamos Scientific Lab., N. Mex.). [1971]. 18p. Dep. NTIS.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

Methods developed and used at LASL for assaying fissionable materials using neutrons produced by either a machine or by radioactive sources as the interrogating radiation are discussed. Examples are given of experiments for measuring the ^{235}U and/or ^{238}U content of fissionable materials such as 320 gr quantities of highly-enriched UAl powder in metal or plastic containers, fuel rods, and samples containing subgram to gram quantities of fissionable material. Six nondestructive assaying methods used with the MONAL are described. It is concluded from this experience that neutron interrogation is indeed a broadly applicable tool for nuclear material assay, and that the number of options available, i.e., radioactive source, machine source, delayed and/or prompt neutron detection, etc., provide a basis on which to design systems to meet a wide spectrum of requirements both economic and technical. (L.C.L.)

48797 (CONF-710617–34) STATISTICAL ANALYSIS OF FUEL ROD SCANS. Zucker, Martin S.; Epel, Lester G. (Brookhaven National Lab., Upton, N. Y.). Jun 1971. 31p. Dep. NTIS.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

Gamma scanning of fuel rods containing plutonium has gained acceptance as a way of determining the uniformity of fuel loading and, to a lesser extent, the total amount of material. The usual electronics for making these measurements includes an analogue ratemeter driving a strip chart recorder. The resulting strip chart recording is hard to interpret in more than a qualitative manner. The use, recently, of a digital ratemeter in a rod scanning apparatus has made statistical analysis of the data much more convenient and prompted such an analysis to be made. The following analyses were performed: a test to see whether at least one segment of the rod differed significantly (i.e., with some confidence limit) from the rest of the rod; assuming that the rod failed the test for homogeneity, the segments were ranked into groups which are statistically homogeneous within themselves; and an attempt was made to find periodicities in the rod due to its internal structure. Also, the gamma spectrum of the whole rod as recorded by a multichannel analyzer during the rod scans was used to try to determine whether significant differences in isotopic composition could be found. Estimates were made of the contribution to the counting rate coming from that part of the rod shadowed by the scanning slits. (auth)

48798 (CONF-710617–36) URANIUM ASSAY BY DELAYED GAMMA RAY ANALYSIS FOLLOWING ^{252}Cf NEUTRON INTERROGATION. Atkinson, G. D. Jr.; Gage, S. J. (Texas Univ., Austin). [1970]. 28p. Dep. NTIS.

A technique for the nondestructive assay of fissionable nuclides is described which utilizes a ^{252}Cf neutron source, cyclic activation, and delayed gamma-ray analysis. The results of preliminary experiments with ^{235}U samples are presented, comparing the effects of various cyclic activation sequences and sample enrichments on the high energy gamma-ray spectra of the short-lived fission products. The quantitative accuracies of the method are also presented. (auth)

48799 (CONF-710617–37) NEED FOR EXPERIMENTAL DATA FOR LEMUF CALCULATIONS. Green, L.; Parsick, R.; Sastre, C.; Suda, S. (Brookhaven National Lab., Upton, N. Y.). Jul 1971. 14p. Dep. NTIS.

The calculation of the limit of error of MUF (LEMUF) must be based entirely on measured quantities of special nuclear material (SNM) that appear in the material balance. Measurement of these quantities must be technically valid and based on good experimental data. An illustration is given, through a sample calculation of the propagated limits of error across the entire material balance of a typical fuel facility of how the systematic and random components of measurement errors contribute to the LEMUF. The example gives a typical list of the materials that must be measured, a set of individual measurement errors that must be estimated and incorporated into the propagated error, and the results of the sample calculations. (auth)

48800 (CONF-710617–38) IDENTIFICATION AND HANDLING OF SOME SIMPLE COVARIANCE EFFECTS IN MATERIAL BALANCE ACCOUNTING. Parsick, R. J. (Brookhaven National Lab., Upton, N. Y.). Jul 1971. 20p. Dep. NTIS.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

The covariance effects illustrated are based on adequate physical protection and surveillance to assure the integrity of most material containers so that only minimal remeasurement of their Special Nuclear Material (SNM) content is required to close the material balance. With assurance based on physical protection and surveillance, the validity of previously measured values could be tested by random sampling and/or by a "shadow" measurement using a quick but relatively inaccurate measurement method, e.g., a nondestructive technique. Under these circumstances, covariance effects resulting from lack of independence for the terms of the Material Unaccounted For (MUF) equation must be considered. A simple source of covariance is discussed and an illustrative calculation of material balance uncertainty (LEMUF) for a hypothetical mixed oxide facility is presented. The results are summarized and show that LEMUF could be significantly reduced by these covariance considerations, depending on facility size, inventory policy, and inventory frequency. The source of covariance considered is especially important for short accounting periods, but other sources of covariance could be significant even for long periods. (auth)

48801 (CONF-710617–39) RELATION OF TECHNICAL AND POLITICAL PROBLEMS IN SAFEGUARDS. Brady, D. W.; Zollman, D. A. (Kansas State Univ., Manhattan). [nd]. 8p.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

An international safeguards system administered by the IAEA involves agreements among nation states first on safeguards policies and, second, on the degree of external control to be allotted to the IAEA. The technical and political factors which will influence decisions on such agreements are discussed. Preliminary results of a questionnaire which sought reactions from individual countries to five hypothetical international safeguards systems are presented and analyzed. (L.C.L.)

48802 (CONF-710617–40) NEUTRON INTERROGATION OF LOW-SPECIFIC-ACTIVITY WASTES WITH A REACTOR. Harlan, R. A.; Cartwright, D. R.; Deal, R. A.; Chanda, R. N. (Dow Chemical Co., Denver, Colo. Rocky Flats Div.). [1970]. Contract AT(29-1)-1106. 25p. Dep. NTIS.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

While there have been very concerted efforts to develop passive and active systems for the assay of drums of waste, scrap and/or finished materials, little attention has been given to systems able to assay drums containing fissile materials at low-specific-activity (LSA) levels. For a typical Rocky Flats drum, the Department of Transportation's definition of LSA wastes would correspond to ~10 mg of plutonium in a drum. These small amounts of material are not particularly important from the viewpoint of accountability. However, LSA drums should be assayed from a safeguards viewpoint to insure that material has not been accidentally or covertly placed in LSA drums. They should be assayed from an environmental viewpoint to insure that there will not be an accidental release of material to the environment during waste disposal. Calculations are presented to demonstrate the feasibility of detecting 1 to 10 mg quantities using a multipurpose reactor. An experimental verification of this feasibility has begun. Available results are presented. (auth)

48803 (CONF-710801–(Vol.1)) PROCEEDINGS OF THE THIRD INTERNATIONAL SYMPOSIUM ON PACKAGING AND TRANSPORTATION OF RADIOACTIVE MATERIALS, RICHLAND, WASHINGTON, AUGUST 16–20, 1971. (Atomic Energy Commission, Washington, D. C. Atlantic Richfield Hanford Co., Richland, Wash. Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 502p. Dep. NTIS.

Thirty-three papers are included; separate abstracts were prepared for each. Seven additional papers that were not available at the time of printing have subsequently been issued as BNWL-SA-3906, and are available from NTIS, 5285 Port Royal Road, Springfield, Virginia 22151. The papers contain information on: transportation safeguards; the AEC accident record and recent changes in AEC Manual Chapter 0529; Celotex insulated shipping contain-

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ers; neutron shielding problem—its effect on spent fuel shipping cask design; practical problems in spent fuel shipping related cask concepts; effect of highway weight limits on cost of spent fuel shipments; and spent fuel transportation experience. (P.C.H.)

For abstracts of individual papers see: 48764 and 48804–48835.

48804 (CONF-710801–(Vol.1), pp 1-24) HOW ABNORMAL IS NORMAL. Sisler, James A. (Department of Transportation, Washington, D. C.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

National and international transport regulations specify numerous test conditions which packages of radioactive and other hazardous materials must be capable of withstanding. The tests were developed by many groups, usually to solve some specific problem. This presentation raises several questions regarding how well the tests represent the transport environment and what should be done to improve our understanding of this environment in order that package tests may be improved. A study for the Department of Transportation by General American Research Division (GARD) has just been completed—a survey of the testing methods and practices currently employed for evaluation of packages. Results of this study are reviewed. Other needed studies are identified. (auth)

48805 (CONF-710801–(Vol.1), pp 25-34) TODAY'S ROLE OF THE DOT IN REGULATING THE TRANSPORT OF RADIOACTIVE MATERIAL. Grella, A. W. (Department of Transportation, Washington, D. C.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

The current role of the U. S. Department of Transportation (DOT) in the exercise of its responsibility for regulating the safe transport of radioactive materials is discussed. A chronological summary is presented of the regulatory highlights of the past 23 years beginning with the first appearance of provisions for radioactive materials in the ICC regulations in 1948 up to the present DOT regulations. The concurrent development of the IAEA regulations and their impact on the development of the domestic regulations are also discussed. The present regulatory functions and roles of the DOT are summarized in light of the most recent and pending rule-making proposals and actions, and concurrent actions of the U. S. Atomic Energy Commission. The role of the DOT in its exercise of the function of Competent National Authority with respect to the IAEA regulations is also discussed. (auth)

48806 (CONF-710801–(Vol.1), pp 36-44) IMPROVING APPLICATIONS FOR SHIPPING CONTAINER APPROVALS. Stevenson, R. L. (Division of Materials [and] Licensing (AEC), Washington, D. C.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

Applications for shipping container approvals submitted to the Division of Materials Licensing (DML) of the USAEC during a 25-month period have been reviewed to identify a number of common deficiencies, as indicated by questions sent to the applicants. Most questions were necessitated by insufficient information concerning structural integrity, containment, and thermal capabilities under the hypothetical accident conditions of 10 CFR Part 71. There are also indications that applicants do not anticipate the whole range of package contents so that frequent license amendments are needed. Recommended procedures for avoiding such problems and the consequent undue licensing effort include the use of checklists, a broad description of the package contents, and quality assurance principles in both the container design and application for approval. (auth)

48807 (CONF-710801–(Vol.1), pp 45-51) A GUIDE TO THE U. S. TRANSPORTATION REGULATIONS. Cornish, Amasa C.; Simens, Hugo (California Dept. of Public Health, Berkeley. Bureau of Radiological Health. Bechtel Corp., San Francisco, Calif.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

The brochure "Shipping Radioactive Materials" has been published by the Bechtel Corporation with the objective of simplifying the U. S. Department of Transportation regulations for the shipment of radioactive materials. It has an action sequence format and uses flow charts whenever possible. The action sequence follows the normal progression one goes through in establishing whether the rules apply to him and what he must do to follow them. The greatest attempt was made to condense, paraphrase, abbreviate, and bring together at one place all pertinent information on each topic in the regulations. (auth)

48808 (CONF-710801–(Vol.1), pp 52-61) THE 1970 REVIEW OF THE IAEA REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIALS. Swindell, G. E. (International Atomic Energy Agency, Vienna (Austria)).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

A brief review is given of the historical development of the IAEA Regulations for the Safe Transport of Radioactive Materials together with a summary of the extent to which they are known to have been adopted by Member States and international transport organizations. A detailed description is given of the procedures for convening an international panel of experts in 1970 to review the regulations as a whole and the working methods adopted. The main changes proposed by the panel at its first meeting are outlined. The comments of Member States on these changes will be considered by the panel at its second meeting in 1971. Reference is made to other recent work of the Agency including the organizing of a seminar on test requirements for packaging for the transport of radioactive materials. (auth)

48809 (CONF-710801–(Vol.1), pp 62-74) HOW CHANGES IN THE IAEA REGULATIONS MAY AFFECT 10 CFR PART 71. Barker, Robert F.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

The Third Revised Draft of the IAEA Regulations for the Safe Transport of Radioactive Material contains many proposed changes in the regulations. The effects of those changes on U. S. transport regulations are discussed in general terms. Among the changes discussed are: leakage rates as criteria for leak tightness; replacing the transport groups with individual radionuclide limits; normal impact test drop height; new requirements for encapsulated special form; changes in the test requirements. It was concluded that the changes may affect the administration and the details of the regulations, but will not alter the basic safety principles. (auth)

48810 (CONF-710801–(Vol.1), pp 75-97) PARTICULAR SOLUTION TO MEET REGULATIONS REQUIREMENTS. Redon, A.; Sousselier, Y.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

Casks that were originally designed for in-site "transfer" purposes of radioactive materials did not fully comply with the transportation regulations. Basically these regulations introduce more drastic requirements as far as containment, heat transfer, and resistance to accident conditions are concerned. Examples of solutions adopted in France to improve such "transfer" cask, in order to use them as "transport" casks, are described. They are based upon the principle of segregation of the packaging functions. This is mainly solved by building special "transport" shells ensuring mainly the resistance to accident conditions (impacts and fire). (auth)

48811 (CONF-710801–(Vol.1), pp 98-105) AEC LICENSING OF THE EXPORT OF RADIOACTIVE MATERIALS AND FACILITIES. Holloway, C. James Jr.; Saltzman, Jerome.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

The Atomic Energy Commission is one of the government agencies licensing the export of commodities from the United States. Under the Atomic Energy Act, the AEC controls the export of by-product material (radioisotopes), source material (uranium and thorium), special nuclear material (plutonium and enriched uranium), and production and utilization facilities (nuclear reactors and fuel reprocessing plants). These AEC-controlled items may be lawfully exported from the United States on authority of a specific license, on authority of a general license, on authority of an exemption from licensing, and for the account of AEC ("government-to-government"). Licensing requirements for each type of material and for facilities are described as well as special requirements for special nuclear materials. The growth of export licensing of SNM is described and analyzed. (auth)

48812 (CONF-710801–(Vol.1), pp 106-12) THE DESIGN AND TESTING OF A LITHIUM HYDROXIDE-SHIELDED CASK FOR THE TRANSPORTATION OF FAST NEUTRON-EMITTING HEAT SOURCES. Seagren, R. D. (Oak Ridge National Lab., Tenn.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

A lightweight shipping package has been designed and constructed for the transport and storage of 250-watt $^{244}Cm_2O_3$ heat sources. The cask was designed to comply with the safety standards of 10 CFR 71 and will meet the requirements of the IAEA Regulations for the Safe Transport of Radioactive Materials. The package, 36 in. in diameter by 58 in. high, weighs approximately 2400 lb. It has an inner cavity 6.8 in. in diameter by 18 in. high. Standard pipe and pipe fittings forming the inner cavity and closures and the roll-formed outer shell are all 304L stainless steel. The 13 in. of neutron shielding and heat transfer media is lithium hydroxide monohydrate with sufficient free moisture content to form a dense, hard mass. The package was tested under varied environmental conditions with a 123-g (305 watt) $^{244}Cm_2O_3$ heat source to determine the optimum lithium hydroxide–water ratio for shielding and heat transfer. The testing program demonstrated that this package effectively contained the 1×10^9 neutrons per second heat source while providing adequate shielding and heat dissipation to meet transport requirements. The design assumptions were verified by the tests, and the concept has been approved by the U. S. Atomic Energy Commission and the U. S. Department of Transportation. (auth)

48813 (CONF-710801–(Vol.1), pp 113-24) TRANSPORTATION SAFETY OF TRANSPLUTONIUM ACTINIDES. Copenhaver, C. M. (Oak Ridge National Lab., Tenn.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

Fissile nuclides, as defined in the transportation regulations, are presently limited to ^{233}U, ^{235}U, ^{239}Pu, ^{241}Pu, and sometimes ^{238}Pu. The fissile definition is reexamined and it was found that nuclides such as ^{238}Pu having a thermal fission cross section greater than 1 barn, but an eta less than one should not be defined as fissile or better included in a fast fissile category. A distinction is generally made between the even and odd neutron actinides with the odd ones being the thermally fissile actinides. The odd neutron actinides are the ones of greatest interest in transportation safety since they have small critical masses in the presence of moderators such as water. In the even neutron actinides such as ^{238}Pu, one is concerned about clumping in solutions since water effectively acts as a poison. Recent cross sections in use at Savannah River, Brookhaven, and Livermore were compiled and used to calculate the critical masses of selected actinides. Minimum critical masses and limiting concentrations for uniform aqueous solutions containing odd neutron actinides ^{242m}Am, ^{243}Cm, ^{245}Cm, ^{247}Cm, ^{249}Cf, ^{251}Cf, and ^{253}Cf were calculated. The total availability in kilograms of various transuranium nuclides are compiled from the literature for the years 1970 and 1980. The estimated availabilities in 1980 combined with critical mass estimates indicate that ^{242m}Am, ^{243}Cm, ^{245}Cm, and possibly ^{247}Cm should be included in the regulations as fissile isotopes. The 1980 quantities of ^{249}Cf and ^{251}Cf are so small that there is no concern about their near term criticality safety on an individual basis. The principal conclusion is that selected odd neutron actinides should be added to the fissile list in Government transportation regulations. Recommendations made include one to perform actinide mixture calculations so any new regulations can be made definitive and avoid being unnecessarily restrictive. Another recommendation is the development of a shielded track calutron so that significant enriched quantities of ^{242m}Am and ^{245}Cm can be obtained. (auth)

48814 (CONF-710801–(Vol.1), pp 125-37) SHIELDED NEUTRON SHIPPING CASK. Hanson, C. L.; Coops, M. S.; Arnold, E. D.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

A shielded neutron shipping cask was designed to transport three-gram quantities of californium-252. The cask weighs 25 tons and may be shipped by common carrier anywhere in the United States. Neutron sources will be packaged in all-metal pressure vessels suitable for use at 1500°F. Three source vessels, each three inches in diameter by twelve inches long, may be stored in a rotating magazine at the center of the cask. An eight-foot-long plug with grapple fingers locks the magazine during transport and is also used to remotely load or unload the neutron-source vessels. A Boral plate is used to absorb slow neutrons and a steel billet provides primary-gamma shielding near the center of the cask. The neutron shield consists of borated limonite concrete and borated gypsum cast into the cavities formed by two concentric steel shells. An additional center core has been designed to transport three 4-inch-diameter by 5-feet-long ^{252}Cf bearing irradiated fuel tubes in this carrier. (auth)

48815 (CONF-710801–(Vol.1), pp 167-84) SINGLE VEHICLE WRECK ON INTERSTATE HIGHWAY, FEBRUARY 1970. Cronin, D. F.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

A single vehicle carrying unirradiated highly enriched scrap in classified form in a DOT approved container (SP-5086, UNC-2600) was wrecked when both rear wheels were lost. The truck went through the guard rail and plunged 60 feet into a small rock-lined drainage ditch; spilled gasoline was present; thus, the standard accident test conditions were almost completely met under actual road conditions. The accident occurred on Interstate Highway 95 in Connecticut. State police reported the wrecked truck and attempted to have the injured driver given medical attention. After initial refusal, the small suburban hospital rendered first aid with follow-up treatment at Yale New Haven Hospital. An emergency crew from United Nuclear Corporation performed radiation/contamination surveys, trans-shipped the special nuclear material and recovered the wrecked vehicle. Coverage by news media was provided from the initial through the recovery phase and was factual with no sensational features. A description of the shipment, a chronological history, photographs, film clips from T.V. news programs, results of surveys, review of problems encountered, reporting to and interaction with various agencies, and internal investigation reports are given. (auth)

48816 (CONF-710801–(Vol.1), pp 185-7) ENRICHMENT ERRORS IN INTERPLANT SHIPMENTS. Dunaway, D. L.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

Experience in receipts of enriched uranium residues (≤10% ^{235}U) indicates significant errors are made occasionally by shippers in ^{235}U enrichment identity. Such errors have serious implications for nuclear criticality safety as well as material accountability. These errors are not easily detected by standard laboratory analyses when the material within a single container is not homogeneous in ^{235}U enrichment or identical throughout a group of containers or for a group of individual fuel rods. Such errors probably would not be detected unless the lot is checked item by item. A quick, nondestructive analysis in which the 185 keV gamma radiation from ^{235}U is measured allows thorough isotopic verification of all enriched receipts in the receiving area. (auth)

48817 (CONF-710801–(Vol.1), pp 188-94) PREVENTING SHIPPING INCIDENTS: TWO CASE STUDIES. Becker, R. C. (California Univ., [Livermore]. Lawrence Radiation Lab.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

Two minor problems in the shipment of radioactive materials led to improved administrative controls at Lawrence Radiation Laboratory, Livermore, California. A plutonium-238 source was found by one recipient within its shipping container but not within a protective inner container. A defective holddown mechanism in another instance allowed an iridium-192 source to shift position within the container from fully shielded to partially shielded. No similar problems have occurred in the past two years. (auth)

48818 (CONF-710801–(Vol.1), pp 195-208) SHIELDED TRANSPORT CONTAINERS FOR INTERMEDIATE AND HIGH-LEVEL RADIOACTIVE WASTES. Bechthold, W.; Heil, J.; Schuchardt, M. C.; Wolf, R. (Kernforschungszentrum, Karlsruhe (West Germany)).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

The shipping of radioactive wastes from the Karlsruhe Nuclear Research Center to the point of final storage in the ASSE salt mine is reviewed. In accordance with the p.a. transport system, drums with low level wastes are carried without any additional shielding. Most of the intermediate level wastes are shipped in a bulk container with variable shielding capable of accommodating seven 200-l drums and weighing between 24.5 and 35 tons, depending upon

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the required shielding. Because of the limited load carrying capacity of the hoisting equipment of the mine, the drums filled with the waste are moved below ground individually in shielded discharge containers. No shielded room is required for changing the drums from the bulk container into the single container. Heat generating high level wastes from reprocessing plants are vitrified and enclosed in steel molds. A study on the optimization of the shipment of these molds indicated that shipment in single containers is the most advantageous way on account of the small quantities of waste to be shipped from Karlsruhe to the ASSE mine in the next few years. These single containers have a steel shielding of 37 cm thickness and a finned surface for dissipation of the afterheat from the fission products. For loading and unloading, the container has a gripping device to pull the glass cylinders into the container and lower them into holes in the mine. This requires no additional shielding. (auth)

48819 (CONF-710801–(Vol.1), pp 210-26) NEW FACILITY FOR PACKAGING RADIOACTIVE LIQUID WASTES. Bloomfield, D. E.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

The development of a process and new facility for the handling and packaging of concentrated radioactive liquid wastes (obtained from a large PWR) is described. The process, demonstrated by preliminary laboratory tests, involves the solidification of concentrated liquid waste evaporator bottoms with a solidification mixture consisting of: cement, vermiculite, and sodium silicate. It is initiated by slowly adding a measured volume of radioactive liquid at a controlled flow rate through a distributor pipe into a 55 gallon drum containing a premixed quantity of the solidifying mixture and does not require the troublesome operations of remote mixing. A description of the facility is given, the initial laboratory scoping tests used to develop the solidifying mixture and demonstrate the feasibility of the process are discussed. (auth)

48820 (CONF-710801–(Vol.1), pp 227-61) DESIGN OF LOW COST FIRE SHIELD FOR SMALL AND LARGE RADIOISOTOPE SHIPPING CONTAINERS. de Lind van Wijngaarden, J. D. W.; Harrod, R. A.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

Type "B" and large source shipping containers nave been equipped with fire shields designed to withstand an 800°C fire for 30 minutes as defined in the IAEA Regulations for the Safe Transport of Radioactive materials. The tests performed on a series of isotope shipping containers weighing from 165 to 6000 kg and methods of calculations used to prove compliance with the regulations are described. Originally the fire shields described were designed to protect existing containers. Because of low cost, low weight, and satisfactory operational experience these types of fire shields are also used on newly designed containers. (auth)

48821 (CONF-710801–(Vol.1), pp 262-71) ENRICHING SERVICES TRANSPORTATION. Robinson, Berwyn M. ([Oak Ridge Operations Office (AEC), Tenn.]).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

The AEC initiated toll enrichment services on January 1, 1969, under Authority of the Private Ownership Act of 1964 and its later amendments. The basic criteria for UF_6 transportation are contained in the standard enriching services agreement with respect to safety, containers, delivery time limitations, FOB points, specifications, and associated responsibilities of the contracting parties. During the initial $2\frac{1}{4}$ years of the program 37,000 tons of UF_6 were delivered, primarily by motor freight. By 1980, the cumulative UF_6 shipments are estimated to total about 500,000 tons with a transportation cost to the nuclear industry of over $20 million. Innovations to current shipping practices, increased volume, use of larger cylinders for enriched product and changes in the economic factors may result in a downward adjustment to the transportation costs. (auth)

48822 (CONF-710801–(Vol.1), pp 272-87) NUCLEAR AND RADIOLOGICAL SAFETY ASPECTS IN TRANSPORTING URANIUM HEXAFLUORIDE. Johnson, W. A.; Newlon, C. E.; Taylor, R. G. (Oak Ridge Gaseous Diffusion Plant, Tenn.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

In an era of expanding technology and computational capability, several studies have been made to better describe safety parameters within AEC and DOT regulations for the transport of uranium hexafluoride. With the projected expansion of the nuclear power reactor program and increased UF_6 flows in both domestic and foreign sectors, these studies become increasingly important as bases for packaging specifications and limitations for safe and economical transport. Because of the current interest in the use of large cylinders for plant storage and their potential for transport, recent nuclear safety analyses have been made of the 48 in. ID heavy-wall UF_6 cylinders. These cylinders have been found safe for ^{235}U enrichments to 4.5% when the hydrogen moderation is controlled at an H/U atomic ratio below 0.088. Some radiological safety aspects in the transport environment are also noted with respect to cylinder cycling operations and potential for buildup of transuranic elements in UF_6 cylinders. (auth)

48823 (CONF-710801–(Vol.1), pp 288-301) ENGINEERING AND QUALITY CONTROL CONSIDERATIONS IN THE SAFE AND ECONOMICAL HANDLING OF URANIUM HEXAFLUORIDE CYLINDERS. Arendt, J. W. ([Oak Ridge Gaseous Diffusion Plant, Tenn.]).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

The uranium industry is on the verge of a tremendous growth because an adequate supply of fuel must be provided for nuclear power. Having pioneered the uranium hexafluoride (UF_6) industry, the USAEC Gaseous Diffusion Plant complex developed methods that have proven successful for over 20 years of operation; these methods are now being offered as standards for the entire nuclear industry. An American National Standards Institute, Inc. (ANSI) subcommittee (N14-8), sponsored by the American Insurance Association, was formed in the summer of 1969 and has prepared a proposed standard, "Packaging of Uranium Hexafluoride for Transport." UF_6 is a very valuable material in the nuclear industry, ranging in dollar value of $23.46/kg U for normal assay, $450.49/kg U for 5% ^{235}U and $10,384.75/kg U for 93% ^{235}U. In addition to the value of the material, cylinders must be properly designed and handled because of pressure, temperature, criticality, and health physics considerations. Adequate consideration must be given not only to the cylinder design but to cylinder handling and packaging to ensure safety and economy in plant operations and during transport. (auth)

48824 (CONF-710801–(Vol.1), pp 302-21) ECONOMICS OF TRANSPORTATION: URANIUM HEXAFLUORIDE. Brooks, G. B.; Freeman, A. T.; Lamb, J. A.; Simpson, W. R.

From third international symposium on packaging and transportation of radioactive materials, Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

The Oak Ridge Operations Office of the Atomic Energy Commission has, since the early 1950's, shipped significant quantities of uranium hexafluoride by various modes of transportation. With the beginning of the AEC's toll enrichment program in January 1969, the volume of uranium hexafluoride moving in the commercial transportation environment has been further increased by recurring flows of normal feed and enriched product between customer facilities, domestically and internationally, and the AEC Gaseous Diffusion Plants located at Oak Ridge, Tennessee; Paducah, Kentucky; and Portsmouth, Ohio. To meet the demands of a rapidly expanding nuclear industry, greater emphasis has been placed on the purchase of transportation services at reasonable cost to meet individual shipper requirements. (auth)

48825 (CONF-710801–(Vol.1), pp 322-35) INDIAN EXPERIENCE IN TRANSPORTATION OF IRRADIATED FUEL. Srinivasan, N.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

Aluminum clad natural uranium metallic fuel irradiated in a 40 MW research reactor is being regularly transported to the reprocessing plant 1 km away from the reactor. Details of the transport flask and the experience in the transportation including unusual incidents are given. Construction of a reprocessing plant for processing irradiated fuel from a 380 MWe BWR power station and a 400 MWe CANDU type power station is in progress. The reprocessing plant will be located within a kilometer from the BWR Station but the other power station is 800 kilometers away. Fuel will be transported from the latter by rail. The details of the different types of flasks for transportation and their design criteria and the reason for choice of mode of transportation are discussed. The peculiar problems in transportation of irradiated fuel in the country and their influence on the size and location of reprocessing plants are outlined. (auth)

48826 (CONF-710801–(Vol.1), pp 336-54) EXPERIENCE IN THE TRANSPORTATION OF RADIOACTIVE MATERIALS IN ITALY. Faloci, C.; Susanna, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

The increasing use being made in Italy of radioisotopes as well as the progressive expansion of large nuclear plants has resulted over the last few years in a substantial increase in the transportation by road of radioactive and fissile materials. In parallel with this increase in the road hauls of radioactive materials there has taken place, in the same period, a substantial change in Italy's road and highway system, with a marked increase in the mileage of the motorways (superhighways) in operation and under construction. The association of these two factors has evidenced the usefulness of a careful technical-safety and health-protection analysis involved in the road hauls of radioactive materials, including on the one hand a study of sites, accidents, and related costs, and on the other the probabilities of accidents. The study of the former factor has led to the formulation of some reservations concerning the acceptability of the accident conditions set forth in the IAEA Recommendations concerning the shipment of radioactive materials in Type A and B packages, such reservations being chiefly prompted by the significant existence on Italian motorways of such structures as viaducts, bridges, and tunnels. The analysis of the latter factor has made it possible to estimate, knowing the motorway traffic statistics and the number of accidents per kilometer, the probabilities of the occurrence in Italy of major or minor accidents involving radioactive materials. These evaluations as a whole have led to the conclusion that in Italy, from the protection standpoint, there are no substantial public-health problems in connection with the transportation of radioactive materials, in consideration chiefly of the low accident probability and of the resulting acceptance, in this respect, of the risk/benefit balance, even though the IAEA Recommendations on containers seem to afford not complete security with respect to a typical traffic accident (auth)

48827 (CONF-710801–(Vol.1), pp 356-79) TRANSPORTATION OF RADIOACTIVE WASTE: WORTH ITS SALT. Brobst, William A. (Atomic Energy Commission, Washington, D. C.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

A new demonstration Federal Radioactive Waste Repository is being proposed for a salt mine at Lyons, Kansas. Progress in the development of a safe transportation system, including package acceptance criteria, that will assure smooth operations at the mine and encourage public acceptance of the repository concept is discussed. Such a transport system requires the coordinated efforts of shippers, carriers, the repository staff, and government regulatory agencies. (auth)

48828 (CONF-710801–(Vol.1), pp 380-98) ATMX-500 RAILROAD CAR RADIOACTIVE WASTE CONTAINER. McDonald E. P. (Mound Lab., Miamisburg, Ohio).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

The development of a radioactive waste container concept, the modifications necessary to achieve a suitable container, and Mound Laboratory's experience in using this container are outlined. The modified ATMX-500 railroad car has been certified as meeting all applicable AEC and DOT requirements and is currently being used under DOT Special Permit No. 5948. (auth)

48829 (CONF-710801–(Vol.1), pp 399-413) ATMX-600 RAILCAR: A NEW CONCEPT IN RADIOACTIVE WASTE SHIPMENTS. Adcock, Frank E.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

The Dow Chemical Company, Rocky Flats Division has been shipping plutonium-contaminated waste to Arco, Idaho, in unique railroad cars known as the ATMX-600. Six cars have been in service since April 1969. All operating experience has been favorable. ATMX-600 cars have removable roof sections to permit loading the 9 × 9 × 50-foot cargo area. Useful load is 101,000 pounds; maximum gross weight is 220,000-pounds. Waste is packaged in plywood crates or steel drums. These in turn are stowed in 8 × 8 × 20-foot steel cargo containers to permit rapid loading of the railcar. An engineering evaluation showed that the railroad transportation environment is favorable, the relative hazard potential of waste shipments is low, and that the ATMX car's performance meets the requirements for Type B packaging. (auth)

48830 (CONF-710801–(Vol.1), pp 415-36) SPENT FUEL TRANSPORTATION: STATE OF THE ART. Peterson, R. W.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

The "State of the Art" in spent fuel transportation is reviewed from the viewpoint of a major fuel recovery plant operator. Spent fuel transportation is viewed as a total service business and scope of services needed by the industry are listed. Technical and economic considerations for each mode of transport are discussed along with the role each mode is expected to play in the future. Cost elements in the total transportation service charges are listed and discussed. Problems in packaging design and licensing, transportation, and public acceptance are also covered. (auth)

48831 (CONF-710801–(Vol.1), pp 437-45) RADIOACTIVE TRANSPORTATION ACTIVITIES FOR A FUELS REPROCESSING PLANT. Wodrich, D. D. (Atlantic Richfield Hanford Co., Richland, Wash.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

The planning of a reprocessing plant for light water reactor fuels requires that considerable attention be given to the receiving, handling, and transport of radioactive materials. Planning for Atlantic Richfield's proposed six tons per day plant includes the handling of 2200 radioactive shipments per year; including spent fuel, uranium, plutonium and neptunium products, and waste materials. The quantities and types of radioactive materials that must be handled result in special considerations and make it necessary to spend tens of millions of dollars for containers and freight charges during the life of the plant. (auth)

48832 (CONF-710801–(Vol.1), pp 447-61) OPERATING EXPERIENCE IN THE SHIPMENT OF RADIOACTIVE MATERIALS. Iya, V. K.; Deshpande, R. G.; Kulkarni, M. D.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

Experience in India in the shipment of radioactive material and the carrier problems encountered is described. The Isotope Division of Bhabha Atomic Research Centre, Bombay, India is responsible for the shipment of all radioactive isotopes and radiation equipment. During the past twelve years, over 100,000 consignments of various radioisotopes have been shipped within India and also to many countries all over the world. The range of radioisotopes shipped vary from the very short-lived to the long-lived and from microcurie quantities to kilocurie quantities. Factors such as physical and chemical form of the radioactive material have a direct bearing on the design of the package. In addition, the mode of transport, shipping distance and transit time have also to be considered. Within the country, shipments of radioactive material are made by passenger aircrafts, passenger trains and road transport. Overseas shipments are made by passenger aircrafts and cargo ships. Problems encountered in persuading carriers to carry radioisotope shipments are described. Both light and heavy packages are used in the transport of radioisotopes. The design of the package takes into account the shipping distance and the transit time, since shipping distances in India are as large as 2000 km and the transit time is often 72 hours or more. Significantly higher quantities of radioactive material have to be dispensed and this necessitates using heavy packages. A few accidents involving radioisotope packages are described. (auth)

48833 (CONF-710801–(Vol.1), pp 462-77) DEVELOPMENT, DESIGN AND CONSTRUCTION OF A SHIPPING PACKAGE FOR TRITIATED HEAVY WATER. Cameron, C. G.; Smith, R. M. (Atomic Energy of Canada Ltd., Pinawa (Manitoba)).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

A package has been developed to transport tritiated heavy water between reactor sites and reconcentration (upgrading) plants. The package consists of a 25 Imperial gallon (114 liter) stainless steel drum mounted within a carbon steel 45 Imperial gallon (205 liter) removable head outer drum. The space between the two drums is packed with a shock and thermal insulant. A prototype package was loaded with light water and subjected to the IAEA Type A and Type B package tests. The outer drum did not rupture, the inner drum was in good order, and the tests proved that the package was safe

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for normal and hypothetical accident conditions of transport. A shipment consists of up to 114 liters (25 Imperial gallons) of tritiated heavy water per package and with a total tritium content of up to 2000 curies. The development and design of this packaging and the results of the test program are described. (auth)

48834 (CONF-710801–(Vol.1), pp 478–89) PROCESSING AND PACKAGING OF SOLID WASTES FROM BWR'S. Loy, H. L.; Saxena, D. C. (General Electric Co., San Jose, Calif.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

Recently several large General Electric Boiling Water Reactor (BWR) power plants in the range of 300 to 800 MW(e) have begun commercial operation. The solids radwaste system for these reactors is reviewed, and predicted solid radwaste generation rates are given. Experience of the operating plants in generating solid wastes is reviewed, including cement fixation of wastes of three operating plants. Low Specific Activity (LSA) classification is reviewed as applied to these wastes. (auth)

48835 (CONF-710801–(Vol.1), pp 490–502) DESIGN CONSIDERATIONS FOR HIGH VOLUME, I.A.E.A. TYPE B PROTECTIVE OVERPACK SHIPPING CONTAINERS IN USE WITH CURRENT TRANSPORTATIONS SYSTEMS. Gablin, Ken (Protective Packaging, Inc., Tacoma, Wash.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

General requirements and the design of two specific containers, the "Paper Tiger" and the "Super Tiger," are given. The Paper Tiger is a container in the form of overpacks for drums or obsolete lead pigs. The Super Tiger outwardly conforms to $8 \times 8 \times 20$ ft international cargo container standards. The Super Tiger has a payload of 30,000 lbs and a capacity of over 500 ft^3 of flexible interior capacity. The interior cavity is $76 \times 76 \times 170$ in. In all cases the Super Tiger is the primary container. (P.C.H.)

48836 (CONF-710801–(Vol.2)) PROCEEDINGS OF THE THIRD INTERNATIONAL SYMPOSIUM ON PACKAGING AND TRANSPORTATION OF RADIOACTIVE MATERIALS, RICHLAND, WASHINGTON, AUGUST 16–20, 1971. (Atomic Energy Commission, Washington, D. C. Atlantic Richfield Hanford Co., Richland, Wash. Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 560p. Dep. NTIS.

Thirty-nine papers are included; separate abstracts were prepared for each. The titles and authors of 10 additional papers that were not available at the time of printing are listed. These papers, available as BNWL-SA-3906 from NTIS, 5285 Port Royal Road, Springfield, Virginia 22151, contain information on: weight minimization of casks for shipment of high burnup and recycle LWR fuels; development of documentation of the transport of radioactive materials; heat transfer calculations for spent fuel during hypothetical accident conditions; a thermal test evaluation method for Pb and U shielded casks; evaluation of Pu form on safety during transportation; shipping system for power grade plutonium oxide; tiedown systems for casks; future trends in automated freight handling systems; design, fabrication and performance testing of Model 160 shipping cask; and shipping casks for spent fuel with high burnup. (P.C.H.)

For abstracts of individual papers see: 48837–48875.

48837 (CONF-710801–(Vol.2), pp 503–15) INSURANCE AND INDEMNITY PROTECTION FOR NUCLEAR MATERIALS IN TRANSPORT. Saltzman, Jerome; Holloway, C. James Jr.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

To provide protection to the general public and promote the growth of the nuclear industry a unique system of liability coverage for nuclear operations including transportation of nuclear materials has been developed. The principal features of the insurance and indemnity aspects of shipments of radioactive materials are: the formation of nuclear liability insurance and nuclear property insurance pools by the casualty and property insurance companies; and the establishment, through Federal legislation, of a program of government indemnity and underlying financial protection (usually nuclear liability insurance) to cover public liability for nuclear incidents. Liability insurance coverage for transportation is provided by means of two basic policies—the Facility Form and the Supplier's and Transporter's Form. Indemnity coverage is supplied to certain licensees and contractors of the Commission. Nuclear property insurance provides first party coverage for certain nuclear property. Some insurance coverage is available for ocean transportation and proposed legislation would extend indemnity coverage for some aspects of ocean transportation. There are also international conventions covering third-party liability of interest to persons involved in the transport of radioactive materials. While certain problem areas remain in the insurance and indemnification of transportation of radioactive materials, by cooperative efforts, these problems can be overcome. (auth)

48838 (CONF-710801–(Vol.2), pp 516–31) THIRD PARTY LIABILITY INSURANCE AND GOVERNMENT INDEMNITY ASSOCIATED WITH THE TRANSPORTATION OF RADIOACTIVE MATERIAL. Cummings, L. G. (Marsh and McLennan, Insurance, New York).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

The increasing frequency of radioactive material shipments throughout the world with its potential risk of financial loss to shippers and transporters has focused considerable attention on the means to minimize or eliminate this risk. One important contribution to meet this challenge in the United States was accomplished by the formation of two nuclear liability insurance pools which make available to private industry third party nuclear liability insurance coverage up to $82,000,000 for Bodily Injury and Property Damage arising out of a nuclear incident. In addition, the Federal Government provides, via legislation known as the Price–Anderson Act, indemnification at certain nuclear facilities including transportation up to $500,000,000 excess of the private insurance coverage. An understanding of the interface between the conventional and nuclear liability insurance policies together with applicable government indemnity is essential if the transportation risk is to be properly insured at minimum cost. Foreign nuclear material shipments also involve unique insurance questions, and certain insurance coverages are available in this field where it is determined that existing international regulations and local liability legislation do not adequately protect the shipper's or transporter's interest. An analysis of the above areas of interest is given, and liability cost factors and loss experience data associated with the shipments of nuclear material are included. (auth)

48839 (CONF-710801–(Vol.2), pp 532–51) PROCESSING RADIOACTIVE SHIPMENTS FROM THE STANDPOINT OF RADIATION SAFETY. Buckland, Carl W. Jr. (Los Alamos Scientific Lab., N. Mex.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

The complexity of current shipping regulations applied to the transport of radioactive materials justifies a procedure that minimizes the chance for human error. The procedures exercised by the Health Physics group of the Los Alamos Scientific Laboratory are presented in detail. Compliance with the regulations has been assured by developing a data sheet to be processed by the Health Physics Surveyor that provides a reminder for each pertinent requirement of the regulations. Once the surveyor has become familiar with the regulations and associates these rules with the corresponding item in the data flow sheet, the chance for overlooking some requirement is minimal. Radioactive shipments from a laboratory are extremely varied in nature. For this reason, the operating groups are encouraged to seek advice from traffic, criticality, health physics and engineering specialists before attempting shipment. The operating group packages their material according to the special requirements for the package specification, Paragraph 173.396 or special permit. At the point of origin, the material packager is required to sign a package certification form for certain containers indicating his conformance with special inner packaging requirements such as ratio of hydrogen to fissile material, special inner capsules, heat load, void space, poisons, absorbers and physical form. All radioactive shipments are indicated as such on the shipping request. Upon receipt of a shipping request that includes radioactive material, the Health Physics group is notified by the shipping department to process the comprehensive data sheet after making the necessary radiation measurements, smears, label selection and double check of curie determinations. Every effort is made by the surveyor to conscientiously examine his finished product for errors or omissions to the point of duplicating prior calculations provided in the "Advance Information Form." He also refers to special permit requirements for completeness of compliance. The data sheet is then reviewed by the traffic manager for violation of any regulation and if found to be satisfactory, signs the certification for receipt by the carrier. A file copy of the data sheet is then reviewed by three supervisory personnel in the Health Physics group for possible further correction and to furnish any constructive criticism to the Health Physics

Surveyor for his future guidance in processing other radioactive shipments. (auth)

48840 (CONF-710801–(Vol.2), pp 552-63) RADIATION SURVEY OF THE TRANSPORTATION OF RADIOACTIVE MATERIALS. Schmidt, Gail D. (Public Health Service, Rockville, Md.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

The current standards for the maximum allowable radiation from packages of radioactive material in transportation were published by the Interstate Commerce Commission in 1947. The surface dose rate limitation of 200 mRem/hr was designed to prevent transportation workers from receiving more than 100 mRem per day during package handling, while the limit of 10 mRem/hr at 3 feet was based upon considerations of exposure to photographic film. Although there has been an excellent record of safety in transporting radioactive materials there is little data available in the literature regarding radiation exposure of transportation workers and the general public or the degree of compliance of radioactive material shipments with the transport regulations. Based upon these considerations the Atomic Energy Commission, Department of Transportation, and Department of Health, Education, and Welfare undertook a joint project to study the matter in greater depth. The survey conducted at 6 geographical locations (and 23 transportation terminals), included a radiation survey of about 300 packages (primarily radiopharmaceuticals). The results of the survey reported include: data on radiation levels from radioactive material packages; an evaluation of radiation exposure to transportation workers; and information on compliance by carriers and shippers with the transport regulations, including labeling, transport index (TI), and separation distances. It was the conclusion of the survey that the radiation exposure of transportation workers under the conditions observed was within permissible limits. A possible exception was noted in the case of radium shipments, which involved only 8.2% of the packages surveyed but represented 56% of the total exposure rate at 3 feet and 39% of the total surface exposure rate. The acceptability of radiation exposure of individuals resulted from the short transit times of packages and the low exposure rates external to the package, rather than carrier compliance with stowage/separation distance requirements. (auth)

48841 (CONF-710801–(Vol.2), pp 564-91) METHOD OF CONTROLLING RADIATION EXPOSURE OF PERSONS IN AIRCRAFT DURING TRANSPORTATION OF RADIOACTIVE MATERIALS. Lecomte, P. A. (Belgian Airlines, Brussels).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

A method is given for calculating segregation distances to be observed between persons and yellow-labelled packages of radioactive materials in aircraft. The method is based on the inverse square rule applied to arrangements of spherical packages with point source located at the center. Surface dose rate and transport index of the package are the two parameters which have been taken into account for computing the segregation distances. An IBM computer 360 was used for the method of calculation and to prepare the graphs. (auth)

48842 (CONF-710801–(Vol.2), pp 592-602) ANALYSIS OF PACKAGING COMPLIANCE TO TRANSPORT REGULATIONS. Labrousse, M.; Lucas, H. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

Methods are given that can be used to prove that a packaging complies with the Type B drop and fire test requirements: calculations, tests on components, and tests on scale models. As regards fire resistance, besides the classical methods, an analytical method giving an approximate solution to Fourier equation is mentioned. As regards drop test, it is shown how to determine the reduction of shielding following an impact and how to determine the elongation of the screws of a closing device. The tests on components allow one to fill in gaps on some badly known particular points. The tests on scale models look promising. However, there are some difficulties in carrying them out. In conclusion, international cooperation is hoped for with a view to developing solutions to these problems. (auth)

48843 (CONF-710801–(Vol.2), pp 603-14) REVIEW OF EXPERIMENTAL STUDIES ON THE FISSLE FUEL SHIPPING CASK *IN* JAPAN. Aoki, S. (Tokyo Inst. of Tech. (Japan)).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

In order to obtain the data necessary to design a spent fuel shipping cask, some experimental studies have been performed in Japan. The Research Subcommittee for Design of Spent Fuel Shipping Cask in the Japan Society of Mechanical Engineers (JSME) performed the experimental study on the heat removal from lead shielding cask for the various decay heat generation rates, which were simulated by means of electric heaters loaded in the cask under steady and hypothetical accident conditions. The temperature distributions in the case of with full coolant, with half coolant, and without coolant were measured and the temperature changes in cask and fuel assemblies were obtained during loss of coolant also. The experimental studies on the drop impact have been carried out by JSME since 1968. Assuming that the prototype cask for light-water reactor would be of horizontal cylinder type weighing about 80 ton, the $1/16$, $1/8$, $1/4$, $1/2.5$, and $1/2$ scale models were fabricated and tested. In these tests deceleration at the moment of impact was measured with accelerometers and deformation of cast was also observed. The relation between drop height and deformation was analyzed. From the fire test by the Fire Institute of Japan, the coefficients of heat transmission on the surface of cask and between steel shell and lead shielding were obtained. The over-the-road tests of a shipping container for PWR type new fuels conducted by Mitsubishi Atomic Power Industries, Inc. (MAPI) gave some valuable data for the compatibility with road condition. The drop tests in PWR type new fuel container were also performed by MAPI. (auth)

48844 (CONF-710801–(Vol.2), pp 615-33) EVALUATION OF METAL SEAL CRITERIA FOR SPENT FUEL CASK CLOSURES. Latham, R. E.; Brown, R. T. (Gray Tool Co., Houston, Tex.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

Reliability of the gasket used for sealing the end closure of fuel casks and mating appurtenances of similar fluid containing piping is of prime importance in overall system evaluation. The degree of reliability will be dependent upon the gasket's ability to respond to relative displacements of the mating seal surfaces during both operational pressure and thermal cycles and superimposed mechanical shock loads that occur during maximum credible incidents. Basic sealing parameters for metal-to-metal gasketed joints, which will result in leakage rates less than 1×10^{-6} cc/sec helium are summarized. The mode of achieving initial minimum seal interface loading to meet this leak rate criteria is evaluated with regard to the material properties of mating connectors and gaskets. The effects of seal geometry and mode of interface loading on the reusability of seals and seal surfaces to minimize replacement and repair are discussed. Economic considerations of manufacturing tolerances for both initial installation and rework operations are reviewed. Coating and plating effects on initial sealing, reusability, and reliability are considered. Overall sealing criteria are summarized for various seal types providing a guideline for designers in gasket selection. (auth)

48845 (CONF-710801–(Vol.2), pp 634-51) RECENT DEVELOPMENTS IN LEAD SHIELDS FOR TRANSPORT CONTAINERS IN THE UNITED KINGDOM. Smith, R. (Lead Development Association, London (England)).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

The manufacture of the earliest transport containers in the UK suffered from lack of liaison between the various interests involved, and the absence of any really satisfactory regulations and testing procedures sometimes had unfortunate results. The introduction of regulations for safe transport tended to make for improved liaison but at the same time brought new problems. While the UKAEA solved the direct problems associated with the new regulations the lead industry was busy developing new techniques of shield manufacture. The use of simple cast shields was gradually being replaced by shields fabricated from rolled lead sheet and slab. Further increases in the size and activity of sources being carried introduced new problems in that the conduction of "source heat" through this type of shield was not very efficient and further development became necessary resulting ultimately in the production of shields made up from a number of smaller cast units thus taking advantage of the best features of both techniques. The cast units provide an efficient transfer of source heat to the outer steel where it is dissipated while the fabrication technique simplifies manufacture and handling problems. The introduction of this combination technique coincided conveniently with

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the introduction of the "heat sink" theory by UKAEA eliminating the need for external packaging on the largest containers. Liaison throughout has now been improved so that designs facilitate the use of the most efficient techniques. Regulations and testing have thus become matters of guidance rather than restriction. Production efficiency is now such that the rigorous testing currently applied is almost unnecessary and is seen in light of testing for approval rather than for rejection. (auth)

48846 (CONF-710801–(Vol.2), pp 652-63) SHIELDING ASPECTS OF LWR SPENT-FUEL SHIPPING CASKS. Engholm, B. A. (Gulf General Atomic, Inc., San Diego, Calif.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

Shielding requirements for light-water-reactor spent-fuel shipping casks were investigated as part of the program on nuclear fuel reprocessing. Comparisons were first made with GE IF 300 cask design. The GGA PATH gamma-shielding code, which can handle three-dimensional multi-material configurations, was utilized for the gamma dose-rate calculations, while both transport and diffusion techniques were applied to neutron analyses. Gamma dose buildup factors for multi-layer configurations were estimated from earlier work performed by GGA for the USAEC. The important nuclide contributors to external dose rates were identified. Following these studies, dry casks were investigated, ranging from a single PWR element capacity to 24 BWR element capacity. Combinations of lead and depleted uranium were studied for gamma shielding, and either borated water or Uniroyal 3807 assumed for neutron shielding. Radiation levels around a dry 4-PWR cask are given. (auth)

48847 (CONF-710801–(Vol.2), pp 664-74) LEAD REMELT EXPERIENCE WITH 60-TON CASK. Lusk, E. C. (Battelle Memorial Inst., Columbus, Ohio).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

The fabrication of large-size spent fuel shipping containers can result in a variety of unanticipated crises. During the fabrication cycle of the NFS-100 cask, (a 60-ton gross weight cask) there was a failure of the lead pouring equipment which necessitated the remelting of 80,000 lb of lead. Since the "lead pour" phase is near the end of a cask fabrication cycle, it was necessary to quickly establish a guaranteed success remelt operation which would result in a nonporous gamma shield. The size of this particular cask and a large number of heat rejection fins necessitated the set up of shroud-type furnace within the metal fabrication shop which would bring the entire cask up to the desired lead remelt temperature of approximately 680°F. Five 750,000 Btu rated liquid propane burners (oriented so the flame was directed tangential to the cask finned exterior) were positioned at several vertical levels and a successful remelt operation was carried out. The details of that operation, as well as the temperature history of the cask are presented. Temperatures were recorded by means of both external thermocouples welded to the cask and dip-type thermocouples employed within the lead volume to establish the liquid/solidus interface and its movement with time. The remelt operation required 27 hours to complete, was completed on site, and resulted in a void-free gamma shield. Specifics of this operation and associated temperature data are given in detail. (auth)

48848 (CONF-710801–(Vol.2), pp 676-88) IMPACT TESTING OF CHEMICAL LEAD, CASK MODELS, AND AN ENERGY ABSORBING DEVICE. Evans, J. H. (Oak Ridge National Lab., Tenn.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

Several impact test programs have been conducted at Oak Ridge National Laboratory, and three recent programs directed toward the development of design and computational data relevant to the 30-ft free drop hypothetical accident condition specified in regulations governing the design and performance of containers in which radioactive materials are shipped are discussed. Chemical lead specimens were impact tested, and the stress-strain properties of lead undergoing gross impact-produced deformation at the strain levels and strain-rate ranges experienced by lead-shielded casks as a result of the 30-ft free drop and impact were determined. Models of a new energy absorbing device, the tubes-in-pipe absorber, were impact tested, and the data and techniques required to predict the behavior of full-size casks equipped with this device were developed. Scale models of the proposed steel-shielded LMFBR shipping cask were impact tested, and the data and techniques necessary to predict the response of the full-size cask were developed and the feasibility of using metal-to-metal seals in such a cask was demonstrated. (auth)

48849 (CONF-710801–(Vol.2), pp 689-707) ADMINISTRATION OF THE RADIOACTIVE MATERIALS TRANSPORTATION SAFETY PROGRAM: OAK RIDGE OPERATIONS OFFICE. Pryor, W. A. (Oak Ridge National Lab., Tenn.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

Transportation safety administration within the Oak Ridge Operations Office is concerned with the implementation of domestic and international regulations. The progress and versatility in shipping container design and utilization are discussed. An account of the planning and experience of shipping irradiated fuel and control rods from a decommissioned reactor is presented. (auth)

48850 (CONF-710801–(Vol.2), pp 708-18) RESPONSIBILITIES OF THE CONSIGNOR AND THE CONSIGNEE. Schendel, K. R. (Westinghouse Electric Corp., Pittsburgh, Pa.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

The responsibilities of the consignor and the consignee with respect to the packaging and transportation of radioactive materials are divided into three general categories–legal, practical, and social. The legal responsibilities are relatively simply stated. However, the regulatory requirements imposed on the consignor and the consignee in preparation for and follow up after the actual movement also are briefly enumerated and indicated to be quite extensive. The practical responsibilities, as discussed, are generally related to financial considerations and to specific properties of or conditions associated with radioactive materials. The social responsibilities are described as relating principally to an overriding requirement for a degree of safety adequate to satisfy the professional standards of the consignor, particularly when those standards exceed the legal minimum. The responsibility for an effective, positive attitude to help to combat the unwarranted distrust of radioactive materials that appears to inflict the general public is also asserted. (auth)

48851 (CONF-710801–(Vol.2), pp 720-6) TRANSPORTATION AND HANDLING OF RADIOACTIVE PHARMACEUTICALS AND RADIOACTIVE CHEMICALS. Sanger, S. H. (Cabs Unlimited, Mountain View, Calif.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

The movement of radioactive pharmaceuticals and radioactive chemicals, either by surface or air or a combination thereof, has been a monumental problem from the inception of the original processing of nuclides due to the short half-life of the commodity. Many precautionary measures must be taken to insure a safe and timely delivery of these radioactive products. From the moment the nuclide has been processed, the problem of packaging and transporting, coupled with the services needed to insure fast portal to portal delivery, is extensive. Both the surface carrier and the air carrier must handle this material with precision-like speed. Packaging, handling, shipping, and transporting are an integral factor in connection with the supply of this product. (auth)

48852 (CONF-710801–(Vol.2), pp 727-39) EXPERIMENTAL STUDY ON THE DROP IMPACT OF SPENT FUEL SHIPPING CASK. Aoki, S.; Nakata, S.; Shimamura, S.; Kanae, Y.; Muramatsu, A.; Nakazawa, H. (Tokyo Inst. of Tech. (Japan)).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

Since 1968 the experimental study on the drop impact test has been performed in Japan. In 1969 the $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2.5}$, and $\frac{1}{2}$ scale models of the assumed prototype of 80 tons in weight were fabricated and tested. In this test, deceleration at the moment of drop impact was measured with accelerometer mounted on the top surface of models. Deformations were also examined. In addition, a high speed 16 mm motion picture was used to analyze the motion of the model at drop impact. The results showed that the relation between the maximum deceleration and reduced scale was approximately linear, and gave about 600 g as the value of the maximum deceleration for the 80 t cask dropped horizontally. The deformation mode of the $\frac{1}{8}$ scale model, and the $\frac{1}{16}$ and $\frac{1}{8.5}$ scale

model in 1968, were significantly different from that of the 1/4, 1/2.5, and 1/2 scale models. Therefore, a model larger than the 1/4 scale should be used to obtain a reliable estimation for prototype from model tests. (auth)

48853 (CONF-710801–(Vol.2), pp 740-53) IMPACT TESTING OF CASK FIN SPECIMENS. Davis, F. C. (Oak Ridge National Lab., Tenn.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

An impact test program was conducted at Oak Ridge National Laboratory to determine the energy absorption characteristics of typical heat transfer or structural fins on shipping casks as these fins undergo dynamic, gross plastic deformation. It was assumed that the energy absorption characteristics of fins welded parallel to the longitudinal axis of a cylindrical cask are linear with respect to their length, and the test program was designed to determine the energy absorption capability per inch of fin length along the cask body. Specimens of typical fin geometries were impacted with free-falling weights dropped from known heights, and the force-time relationships occurring during each impact were recorded. A computer program was used to convert the test data into deformation-time and energy-time relationships. These relationships were correlated in a set of curves that enable the cask designer or analyst to compute the energy absorption capacity of a longitudinal fin on a cask as a function of its geometry and the percentage of deformation it is expected to experience as well as the peak force the fin would experience during the impact resulting from a 30-ft free drop onto an essentially unyielding horizontal surface. (auth)

48854 (CONF-710801–(Vol.2), pp 754-72) IMPACT TESTS OF MODELS AT THE SAVANNAH RIVER PLANT. Langhaar, J. W. (Du Pont de Nemours (E. I.) and Co., Wilmington, Del. Atomic Energy Div.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

Impact testing of small-scale models for assessing gross deformation resistance to puncture, behavior of welds, and certain other physical attributes has been theoretically established and experimentally verified. For evaluation of the strength of bolted fastenings and leakage of closures, the validity of model testing is not so well proven but is nevertheless often considered the most reliable practical method available. The Savannah River Plant has tested numerous models in recent years and sometimes a full-size mockup of part of a package. Results in some cases have confirmed predictions and other cases have necessitated a change in design. Several of the tests are described. The need for further study of methods of modeling closures is emphasized. (auth)

48855 (CONF-710801–(Vol.2), pp 773-84) PREDICTION OF DEFORMATION AND DECELERATION OF A COMPOSITE CYLINDRICAL BODY FOR THE CORNER DROP CASE. Lee, K. (ATCOR, Inc., Elmsford, N. Y.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

Using the concept of dynamic flow pressure, an energy balance was developed for the impact condition of a corner drop. The wedge shaped deformation as well as the deceleration of a composite cylindrical body caused by a corner drop was then related to the energy level of the impact. Results predicted by this empirical corner drop correlation were compared with the cask drop tests performed by H. G. Clarke. The agreement was reasonably good. (auth)

48856 (CONF-710801–(Vol.2), pp 785-91) ECONOMICS, COMPOSITIONS, AND PROCESS EQUIPMENT FOR RADIOACTIVE WASTE SOLIDIFICATION. Rutland, L. (ATCOR, Inc., Elmsford, N. Y.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

From ecological and safety considerations, solidification of radioactive wastes results in a desirable waste product form for transportation and subsequent disposal. Government regulations may and some commercial burial facilities now require radioactive wastes from nuclear plants to be handled as a free standing solid waste product. Suitable solidified radioactive waste product compositions, economic considerations associated with transportation and disposal, and a waste solidification process system are discussed. (auth)

48857 (CONF-710801–(Vol.2), pp 792-802) APPLICATION OF FISSILE MATERIAL STORAGE LIMITS TO CRITICALITY SAFETY ANALYSIS IN TRANSPORT. Thomas, J. T. ([Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant]).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

Knowledge of the criticality of spaced subcritical spherical masses in water-reflected cubic arrays can be used to estimate allowable mass limits for containers of fissile material in transportation. Calculated criticality data for representative fissile materials are tabulated. The methods of calculation as well as the techniques required to employ the data in the solution of arbitrary problems of array criticality are described. Monte Carlo-determined critical arrays characterize criticality for various forms of fissile materials and the factors affecting their criticality. Applications of the data and methods to typical transport containers are given. (auth)

48858 (CONF-710801–(Vol.2), pp 803-21) CRITICALITY SAFETY EVALUATIONS OF SHIPPING CONTAINERS USED BY IDAHO NUCLEAR CORPORATION AT NRTS. Fox, J. K.; Morrison, W. G. (Idaho Nuclear Corp., Idaho Falls).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

The results of several criticality safety evaluations of fuel shipping containers are given. The containers included casks for shipping irradiated fuels, as well as containers for unirradiated fuels and other fissile materials. These containers all contain poisons such as cadmium and boron to assist in maintaining subcriticality and their presence must be assured. Most of the containers evaluated gave k_{eff} values that were quite low even for the most reactive credible condition. The k_{eff} values obtained for these conditions were between about 0.40 and 0.85 for the containers tested. In some cases, the k_{eff} values were below unity even when poison was omitted. The methods used involve the use of several reactor codes. The accuracy of these methods has been thoroughly checked by comparisons with clean critical experiments. (auth)

48859 (CONF-710801–(Vol.2), pp 822-32) ATMX RAILCAR: NUCLEAR SAFETY EVALUATION. McCarthy, J. D. (Dow Chemical Co., Golden, Colo. [Rocky Flats Div.]).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

A Nuclear Safety Analysis of the ATMX-600 Series Railcar showed that this railcar meets the requirements for Class I Shipments, as specified in the Appendix to AEC Chapter 0529. This railcar is used for shipping waste material mixed with fissile material. (auth)

48860 (CONF-710801–(Vol.2), pp 833-45) STUDY ON FIRE RESISTIVITY FOR IRRADIATED FUEL SHIPPING CASKS. Moriya, T.; Shimada, H. (Fire Research Inst. of Japan, Tokyo).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

Attempts were made to assess the fire resistivity of spent fuel casks. Heat durability experiments were made in a furnace for two cask models of different dimensions. It was found that when the experimental results were analyzed with an Analog computer, the air gap between the lead shield and the outer shell affects largely the heat resistivity of casks. The analysis in which the heat generation from spent fuel is taken into consideration suggests that the prototype casks are fire-resistive enough for their lead to be kept unmelted against the 800°C fire of a period of 30 min. (auth)

48861 (CONF-710801–(Vol.2), pp 847-59) SHIPPING CONTAINER DESIGN FOR FIRE ACCIDENT PROTECTION, MINIMUM RESTRICTION TO DECAY HEAT REMOVAL. Serkiz, A. W.; Lusk, E. C. (Battelle Memorial Inst., Columbus, Ohio).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

Fire survival requirements impose various constraints on the design of nuclear material shipping container designs. The result has been, in many cases, a bulky package that is difficult to handle, load or unload, and quite susceptible to environmental conditions. Casks which must ship spent fuel assemblies having a high level of decay heat are presently considered to be a major

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design problem. However, the small casks (which often have a negligible amount of decay heat) must also survive the fire environment and not lose their shielding capability as specified by the AEC–DML regulations. Methods used in the past have included wood overcoats, concrete or water impregnated materials, and more recently, organic materials such as used in the Paper Tiger concept. Several design techniques which have evolved over a number of years at Battelle–Columbus and which are based on the optimal use of various cask components to serve a multiple function (i.e., structural and thermal protection) are outlined. Several of the more obvious techniques are the use of external heat rejection fins, multiple or laminated structural shells, and water-filled outer shells which also serve as neutron shields. Several cask concepts and the calculated thermal response of these cask systems when they were subjected to the hypothetical fire specified in the AEC 10–CFR–Part 71 regulations are presented. (auth)

48862 (CONF-710801–(Vol.2), pp 861-72) DROP TESTS OF SHIPPING CONTAINERS FOR PWR TYPE NEW FUELS. Seki, Y.; Nakata, S.; Kanae, Y.; Aoki, S.; Shimamura, S.; Koguchi, T. (Tokyo Inst. of Tech. (Japan)).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

For the purpose of evaluating shock absorbing characteristics and structural integrity, a series of drop tests was conducted on two sizes of prototype shipping container for light water reactor new fuel assemblies. The No. 1 prototype container, which was designed to ship large PWR fuel assemblies, was drop tested from the height of up to 90 cm onto an essentially unyielding horizontal surface installed at the Government Mechanical Laboratory of Japan, while the No. 2 prototype, which was designed to ship small fuel, was drop tested from the height of up to 1.2 m and 9 m. Decelerations at the fuel receptacle and the container shell, displacement of the fuel receptacle, and dimensional changes of shell were recorded and evaluated. (auth)

48863 (CONF-710801–(Vol.2), pp 873-85) SHIPPING PACKAGE FOR UNIRRADIATED POWER REACTOR FUEL ASSEMBLIES. Kropp, R. E. (United Nuclear Corp., New Haven, Conn.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

A package for the shipment of unirradiated power reactor fuel assemblies was designed, tested, and then used during the past four years. This package is identified as model UNC 2800 and was issued DOT Special Permit No. 5419. Evaluations were performed using criteria set forth in the AEC and DOT Regulations for fissile material packages. Nuclear safety analyses were performed using empirical techniques. Although less exacting than computer analyses, these techniques yielded conservative results. Operating needs resulted in modification of the loading of this package. Nuclear safety analyses associated with this modification were performed using reactor design computer codes. (auth)

48864 (CONF-710801–(Vol.2), pp 887-904) COMPACT METALLIC IMPACT LIMITERS FOR SHIPPING CONTAINERS. Burian, R. J.; Lusk, E. C. (Battelle Memorial Inst., Columbus, Ohio).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

Two types of all-metal impact limiters have been developed to protect radioactive shipping containers from damage due to accident conditions such as those outlined in the AEC 10–CFR–Part 71 Regulations. One type is designed to protect the shipping container from blows directly on the end or on an edge at the critical oblique angle. This type of impact limiter is comprised of a cluster of metal tubes or a welded metallic honeycomb within a specific array. The kinetic energy of the container is absorbed by plastic strain of the tubes or honeycomb structure, which in turn protects the cask from deformation and excessive forces which could damage the container or its contents. This type of impact structure is fully enclosed in a metallic shell (normally stainless steel) for corrosion reasons and easing decontamination. The development of the design is detailed and the mechanics of applying the design equations are also illustrated. The second type of limiter is designed to protect the shipping container from impact on the side. This design incorporates metallic tubes, partially filled with water, attached to the surface of the shipping container so that the tube axis is parallel to the container axis. Upon impact the tubes are deformed causing the pressure in the tubes to increase. At a pre-designed pressure, relief ports open and the water is expelled through orifices. The kinetic energy of the cask is absorbed not only by plastic deformation of the tube but also by the inertia and viscous losses in the water as it is expelled. The water also serves as a neutron moderator for containers which are used to ship neutron emitting materials. (auth)

48865 (CONF-710801–(Vol.2), pp 905-33) SHOCK AND VIBRATION MEASUREMENTS DURING NORMAL RAIL AND TRUCK TRANSPORT. Foley, J. T.; Gens, M. B. (Sandia Labs., [Albuquerque, N. Mex.]).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

At the suggestion of Division of Construction, Headquarters AEC, the Union Carbide Corporation invited the Environmental Criteria Group of Sandia Laboratories to participate in a transportation test involving the transportation of a radioactive materials (RAM) cask from Paducah, Kentucky, to Oak Ridge, Tennessee, by railroad and the return to Paducah by truck. Sandia instrumented the vehicles and measured the shock and vibration inputs to the RAM cask. The conduct of the Sandia data experiments is reviewed, the instrumentation is described, the data reduction techniques used are discussed, and the resulting data are presented in summary form. The summarized data provide a comparison of the intensity of the shock and vibration encountered in the rail and truck transport environments. The main purpose of the Sandia participation was to obtain data to be used in applied research pointed towards developing descriptions of environmental inputs to cargo. The rail shipment covered approximately five-hundred miles of varied terrain. The truck shipment was approximately three-hundred miles in length. A team of Sandia engineers and technicians planned the experiment and carried it out. Data reduction and interpretation was part of the Sandia contribution. The instrumentation system was operated remotely from the cabooses of the trains involved, but directly from the cab of the truck. Piezoelectric accelerometers were employed to measure shock and vibration. Summaries of the reduced data as well as the methods of data reduction are discussed. Summaries of the reduced data are presented in a form which permits comparison of the environments produced by rail and truck modes of transportation at the "input to cargo" interface. When the variable dynamic characteristics of general cargo were considered in conjunction with these environment comparisons, the differences in the two modes of transport were found not to be significant from a shock and vibration standpoint. (P.C.H.)

48866 (CONF-710801–(Vol.2), pp 934-43) UPGRADING OF PM-3A CASKS. Scaggs, R. A.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

Four casks were fabricated nine years ago for shipment of spent PM-1 and PM-3A fuel cores from small power reactors at Sundance, Wyoming and McMurdo Sound, Antarctica. The casks have remained in service for the latter reactor. Compliance with present U. S. and International Atomic Energy Agency regulations for shipment was considered doubtful because of possible failure of the closure and possible loss of molten lead under hypothetical accident conditions. Upgrading of two of these casks was undertaken at the request of the AEC. The casks were restored to useful service by extending the protective shroud, installing an insulating plate under the cask, modifying the tie-down devices and lifting trunnions, and modifying the cask seal. As part of the program to show compliance with shipping regulations, impact and leak tests were performed on a 500-lb, ¼-scale test model. Calculated temperatures during the hypothetical fire indicated that the protective shroud will prevent melting of the lead shielding. A nuclear safety study showed that the shipment would comply as Fissile Class I, provided no water leaked into the casks. Leak tests on the model after the drop tests demonstrated the integrity of the seal. After all modifications, the casks were hydrostatically tested at 30 psig and pneumatically leak tested at 20 psig, well above the maximum expected pressure 7 psig. Heat dissipation tests were then performed. (auth)

48867 (CONF-710801–(Vol.2), pp 945-72) QUALITY CONTROL OF SHIPPING CASK FABRICATION. Short, Allen (Vitro/Hanford Engineering Services, Richland, Wash.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

Vitro Hanford Engineering Services recently redesigned and inspected the modification of a cask (HAPO–1C–1) for shipping

cesium-137. Safety requirements involving structural and containment integrity were understandably high. To achieve this conformance to stringent safety criteria, a carefully devised and administered quality-control program was prepared and implemented. Because of the complex structural configuration of the cask, a detailed fabrication plan was prepared to insure that each component was correctly installed in the proper sequence. This fabrication plan provided the framework for the ensuing quality-control program. Every requirement for conformance to codes, specifications, and drawings was carefully listed for each step in the preparation of every component and for the subsequent assembly of components to complete the fabrication. Thus, a "control" document evolved that was completely comprehensive and chronological in arrangement. An adequate force of carefully instructed and experienced inspectors maintained constant surveillance over every facet of fabrication and assembly. (auth)

48868 (CONF-710801–(Vol.2), pp 974-88) URANIUM CASK FOR SHIPMENT OF FORT ST. VRAIN HTGR SPENT FUEL. Davis, C. R. (Gulf General Atomic, Inc., San Diego, Calif.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

The Fort St. Vrain fuel shipping cask was the first uranium-shielded containment vessel to be licensed by the USAEC for commercial transport operations. The uranium shield is fabricated of cast cylinders encased in stainless steel. The use of uranium permits the highest possible ratio of HTGR spent fuel element weight to cask weight for legal-weight truck transportation. The significant design features and engineering analyses used to satisfy the federal regulations for normal transportation and for hypothetical accident conditions are given. (auth)

48869 (CONF-710801–(Vol.2), pp 990-4) GENERAL DESCRIPTION OF EXPECTED SIZE AND CAPABILITY OF 1100 MWe REACTOR SPENT FUEL SHIPPING CASKS. Malone, J. P. (ATCOR, Inc., Elmsford, N. Y.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

A general consideration of the design parameters for 1100 MW(e) reactor spent fuel shipping casks permits reasonable estimates to be made of the expected size and capabilities of future spent fuel casks for 1100 MWe reactors. The allowable weight of the cask, the required length, and the shielding thickness are factors used to determine the expected cavity diameter. The cavity diameter and the heat transfer requirements are then employed to estimate the spent fuel capacity of the cask. (auth)

48870 (CONF-710801–(Vol.2), pp 995-1006) CONTRIBUTION TO THE DESIGN OF TYPE B PACKAGES FOR HIGH RESIDUAL POWER IRRADIATED FUELS ELEMENTS. Bruel, Henri; Bochard, Camille.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

The cost of the fuel cycle and especially of shipping irradiated fuels deserves the specialists' attention, taking into account the large number of power stations being presently erected. However, the LWR fuels characteristics entail new technical problems concerning the thermal evacuation and the neutron shielding of the casks. The solutions raised by the ROBATEL SLPI Company, casks designers and manufacturers, to solve these problems while stressing the economical and safety aspects are summarized. (auth)

48871 (CONF-710801–(Vol.2), pp 1007-14) AN LMFBR FUEL SHIPPING CASK CONCEPT AND OBSERVATIONS PERTAINING TO HAZARD SURVIVAL POTENTIAL. Irvine, A. R.; Shappert, L. B. (Oak Ridge National Lab., Tenn.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

Shipment of irradiated fuel from liquid-metal-cooled fast breeder reactors (LMFBR) is expected to be accomplished after a short decay period. The existence of gross amounts of dispersible radioiodine and radioactive rare gases at short decay times makes the ability of the shipping cask to survive accidental hazards a matter of prime concern. The favored design for an LMFBR fuel shipping cask employs steel for both gamma radiation shielding and the cask structure. Heat is transported within the sealed fuel cavity by thermal convection in a sodium bath that surrounds multiple fuel subassemblies. Cask seals are designed to minimize the probability of damage due to impact, and to be capable of leak-free performance at elevated temperature and pressure. The fuel subassemblies are supported within the fuel cavity by means of a rotatable magazine such that they can be placed in and removed from the cask through a relatively few small ports. Cask temperature under normal conditions is maintained, by a special cooling system, at a moderate level in order to optimize cask material strength and ductility, as well as to increase the quantity of heat required to elevate the cask temperature to the maximum permissible level. Upon loss of secondary cooling, the cask temperature would rise to a sufficient level to dissipate the decay heat to the atmosphere. Additional protection against damage due to impact is provided by an array of energy-absorbing buffers located in the vicinity of the seals and at other strategic points. Results of impact tests with various scale model casks, heat transport experiments with liquid coolants, and calculations of thermal transients indicate that a rail shipping system which can resist credible impact and fire hazards can be designed and constructed at reasonable cost. (auth)

48872 (CONF-710801–(Vol.2), pp 1015-27) AIR CUSHION SUPPORT FOR HIGHWAY TRANSPORT OF HEAVY LOADS. Trask, W. H. (Battelle Memorial Inst., Columbus, Ohio).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

Air cushion technology is defined and related to applications in highway hauling. Equipment design requirements are discussed. Load spreading as a highway "preserving" technique is introduced with consideration for bridge capacities. The technology and economics of cushion support applied to spent fuel hauling are briefly considered. The possible effects of cushion vehicles on highway regulations are predicted. Finally, the role of highway commissions in developing cushion support technology is suggested. (auth)

48873 (CONF-710801–(Vol.2), pp 1028-41) COMPUTER MOVIES FOR SIMULATION OF MECHANICAL TESTS. Baker, L. H.; Donham, B. J.; Gregory, W. S.; Tucker, E. K. (Los Alamos Scientific Lab., N. Mex.).

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

Evaluation of results produced by digital computers need not be a tedious process of number evaluation. By means of the basic models used in simulating the effects of the 30-ft fall and the fire test of shielded shipping containers, computers can be programmed to produce a visual record of the results of the calculation in the form of geometric images. Viewed in rapid succession these images form a motion picture of the modeled process. A number of different schemes may be employed to depict the numerous variables involved. Whenever possible the various phenomena should be presented with generally accepted representations. Color, for example, may be used to represent temperature, while shape changes may be directly represented by a corresponding geometric presentation. (auth)

48874 (CONF-710801–(Vol.2), pp 1043-51) HEAT TRANSFER ANALYSIS OF A ^{137}Cs SHIPPING CASK. Bray, G. R.; Darby, J. J.; Gruhl, C. E.

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

The shipment of cesium-137 from Richland, Washington, to Oak Ridge, Tennessee, required the design of a new shipping cask. Design factors were based on the structural integrity of the cask and the maximum volume of product that could be contained per unit of product heat generated under varying conditions. Conventional calculations were used in the cask's design, and then a computer program was developed to confirm them. In addition, steady-state temperatures were taken with various cask loadings. (auth)

48875 (CONF-710801–(Vol.2), pp 1052-62) A STUDY OF THE EFFECT OF IMPACT AND OF THE USE OF A TOROIDAL SHELL AS AN ENERGY ABSORBER ON A CYLINDRICAL CONTAINER OF LEAD AND STEEL. Shobe, L. R.; Dewey, B. R.

In Proceedings of the third international symposium on packaging and transportation of radioactive materials.

Test specimens of 0.167 scale model of a full size container were dropped from 30 ft to determine their behavior during impact, their behavior during rebound, and the nature of the deformed regions. The severe damage experienced by the cylindrical specimen casks and the limited ability to absorb energy without failure lead to the development of a steel toroidal shell attached in such a way as to give maximum

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protection in corner impact. An approximate analysis of the energy absorption of such a shell and experimental verification showed that the stress state in the toroidal shell increased the shell's energy absorption by orders of magnitude over simple rings. A drop test with a toroidal shell attached to a scale cask substantiated the efficacy of this approach—a 14-lb model shell completely protected a 233-lb model cask. This represents a small percentage increase in weight for a major increase in protection against impact. (auth)

48876 (DP–1261) AUTOMATIC FIRE EXTINGUISHING SYSTEMS FOR GLOVE BOXES AND SHIELDED CELLS AT THE SAVANNAH RIVER LABORATORY. Hill, Arthur J. Jr. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Jun 1971. Contract AT(07-1)-1. 15p. Dep. NTIS.

An automatic fire-extinguishing system has been designed and tested for protection against non-metallic fires in glove boxes and shielded cells at the Savannah River Laboratory. The shielded cells and a number of glove boxes are currently protected by manually actuated systems pending conversion to automatic systems as operations permit. (auth)

48877 (DPSPU–71-124-4) SAFETY SUMMARY REPORT: SPERT-III FUEL IN PADUCAH DEMONSTRATION CASK (PACKAGING OF RADIOACTIVE AND FISSILE MATERIALS). Final Report. Scaggs, R. A. (comp.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). Jun 1971. Contract AT(07-2)-1. 92p. Dep. NTIS.

Spent SPERT-III reactor fuel is shipped in the Paducah Demonstration Cask in compliance with regulations for safe transport of radioactive and fissile materials. The cask is 50.75 in. high inside and has an ID of 17 in. and an OD of 30 in. at the base of the fins which are 3 in. high. The wall consists of an inner stainless steel shell 0.25-in.-thick, 5.75 in. of laminated uranium, and an outer stainless steel shell 0.50-inch-thick. The cask with its fuel load weighs about 30,000 pounds. (auth)

48878 (DPSPU–71-124-5) SAFETY SUMMARY REPORT: BORAX V FUEL IN BISMUTH CASKS (PACKAGING OF RADIOACTIVE AND FISSILE MATERIALS). Final Report. Scaggs, R. A. (comp.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). Jul 1971. Contract AT(07-2)-1. 37p. Dep. NTIS.

Loose rods of Borax V fuel are to be shipped from Idaho Falls to the Savannah River Plant in "Bismuth Casks." These casks are approved for the shipment of polonium but they have not been previously approved for the shipment of fissile material. Previous analyses for normal transport and hypothetical accident conditions are supplemented and used as the basis for qualification of the casks. (J.R.D.)

48879 (GULF-RT–10697) APPLICATION OF PHOTOINDUCED REACTIONS TO NUCLEAR MATERIALS SAFEGUARDS PROBLEMS. Quarterly Progress Report, January 1, 1971–March 31, 1971. Bramblett, Richard L.; Costello, D. G.; Ginaven, R. O.; Naliboff, Y. D.; Rundquist, D. E.; Trimble, G. D. (Gulf Radiation Technology, San Diego, Calif.). 22 Jun 1971. Contract AT(04-3)-167. 47p. Dep. NTIS.

The research and development performed during the period January 1, 1971 to March 31, 1971, on techniques and application of nondestructive measurements of nuclear materials is described. Work was largely devoted to the field test of the mobile assay system (GAMAS) at the Rocky Flats Division of Dow Chemical. The Rocky Flats field tests involved plutonium standards and production waste, where both active and passive nondestructive assays were performed. Active assay was performed on large heterogeneous containers of nuclear waste by photoinduced methods. For 55-gallon barrels of well-segregated waste with uniformly distributed plutonium, a standard deviation of less than 8% was demonstrated, and with limited segregation the standard deviation was 15%. Passive scans were also performed using a sodium iodide detector as well as neutron detectors. The results of the passive measurements on the standard barrels show a standard deviation of 7% for the passive gamma-ray measurements and 6% for the passive neutron measurements when the calibration was obtained from standards furnished by Rocky Flats. The results of measurements using the Isotopic Source Assay System are also discussed. This system was used for the assay of 1-gallon containers of Pu scrap. Both passive measurements of the ^{240}Pu content and direct active measurements of the ^{239}Pu content were made. The passive results indicate an accuracy of 5% for heterogeneous material, and the active results indicate 7% accuracy for the same type of material. (auth)

48880 (IAEA-R–877-F) VERIFICATION OF REACTOR BURNUP AND PLUTONIUM CALCULATIONS BY MEASUREMENTS IN A REPROCESSING PLANT. Bokelund, H. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Sep 1970. 60p. (ETR–265).

The verification of reactor calculations by measurements made on dissolved fuel in a reprocessing plant is considered. For highly enriched uranium fuels the ^{235}U depletion calculated for 16 different reactor cores is compared to the ^{235}U depletion found from isotopic analyses of uranium. Values of α_5, the capture-to-fission cross-section ratio for ^{235}U, were also found from the measurements. For low enriched uranium fuels the calculation of burnup on 14 different cores was compared to burnup values found by measuring the change in the heavy element isotopic composition and by measurements of ^{148}Nd as a fission indicator. The estimate of plutonium was compared to the Pu/U ratio measured. The measured amounts of uranium were compared to the initial amounts of uranium, corrected for burnup, so as to verify input accountability measurements. For both types of fuel, coefficients of various relationships between measured or derived parameters are tabulated for the purpose of characterizing fuels from a specific reactor for future recognition. (auth)

48881 (ORNL-TM–1312(Vol.10)) STRUCTURAL ANALYSIS OF SHIPPING CASKS. VOL. 10. AN EXPERIMENTAL AND ANALYTICAL EVALUATION OF THE TUBES-IN-PIPE ENERGY ABSORBER. Evans, J. H. (Oak Ridge National Lab., Tenn.). Jul 1971. Contract W-7405-eng-26. 68p. Dep. NTIS.

The tubes-in-pipe energy absorber was investigated experimentally and analytically to determine its general effectiveness as a protective device for containers in which radioactive or fissile materials are transported. Energy absorber specimens of different geometries were impact tested, and the resulting force-time data were transformed into force-deflection data. Equations were written to predict the force applied and energy stored in a tubes-in-pipe energy absorber of a particular geometry for a known or assumed deflection experienced by the absorber. It was concluded that the tubes-in-pipe energy absorber is an efficient and practical device that can be effectively used to store energy and reduce the deformation and accelerations experienced by full-size shipping casks under impact conditions. (auth)

48882 (ORNL-TM–3506) SAFETY ANALYSIS OF ORNL BULK RADIOISOTOPE SHIPPING CASK. Seagren, R. D. (Oak Ridge National Lab., Tenn.). Aug 1971. Contract W-7405-eng-26. 43p. Dep. NTIS.

An analytical evaluation of the ORNL Bulk Radioisotope Shipping Cask was made to demonstrate its compliance with the regulations governing packages in which radioactive material is shipped. Computational procedures were used to determine the structural integrity and thermal behavior of the packaging with respect to the general standards for packaging, structural standards, standards for normal conditions of transport, and the standards for hypothetical accident conditions. The results of this evaluation show that the packaging complies with all the applicable regulations. (auth)

48883 (PB–189506) PROCEEDINGS OF THE CONFERENCE ON THE TRANSPORTATION OF RADIOACTIVE MATERIAL [HELD IN CHARLOTTESVILLE, VIRGINIA], OCTOBER 26–28, 1969. (Virginia Univ., Charlottesville). 28 Oct 1969. 152p. (UVA-TRM–1; CONF-691059). NTIS.

A separate abstract was prepared for each of the thirteen papers presented. (D.H.M.)

For abstracts of individual papers see: 48884–48896.

48884 (PB–189506, pp 1-11) TRANSPORTATION OF RADIOACTIVE MATERIAL: THE PROBLEM. Corbett, J. Stewart (Virginia Univ., Charlottesville).

From Conference on the transportation of radioactive material; Charlottesville, Va. (26 Oct 1969).

In Proceedings of the conference on the transportation of radioactive material.

It was concluded that no significant problems exist in the area of transportation of radioactive materials regardless of the kinds and quantities involved. Containers have been developed that will adequately contain radioactive materials under all conditions anticipated in transit, and regulations are in effect that are directed to the hazard of the specific material to be shipped. The only real need is an educational program by all groups, industry, the carriers, the public, etc. (D.H.M.)

48885 (PB–189506, pp 12-41) REVIEW OF THE DEPARTMENT OF TRANSPORTATION (DOT) REGULATIONS FOR TRANSPORTATION OF RADIOACTIVE MATERIALS. Grella, Alfred W. (Department of Transportation, Washington, D. C.).

From Conference on the transportation of radioactive material; Charlottesville, Va. (26 Oct 1969).

In Proceedings of the conference on the transportation of radioactive material.

The major features of the DOT regulations for transport of radioactive materials are reviewed and some suggestions are offered for interpreting and using the regulations. The newly developed transport regulations amendments, based on the IAEA standards, accomplish the following: more emphasis is placed upon the effects of serious transportation accidents on the performance of packaging; a reclassification of radionuclides with associated packaging standards is now based on relative radiotoxicity considerations and the potential hazard of the contents, rather than solely on the type of radiation emanating from the package, a new labeling system for radioactive materials is established, and provisions are included for more types of specification packaging for radioactive materials. (D.H.M.)

48886 (PB–189506, pp 42–60) AEC REGULATIONS FOR THE PACKAGING OF RADIOACTIVE MATERIALS FOR TRANSPORT. Nussbaumer, Donald A. (Division of Materials and Licensing (AEC), Washington, D. C.).

From Conference on the transportation of radioactive material; Charlottesville, Va. (26 Oct 1969).

In Proceedings of the conference on the transportation of radioactive material.

The basic objectives, concepts, and principal provisions of AEC regulations for the packaging of radioactive materials for transport (10 CFR Part 71 of the Code of Federal Regulations) are described. The potential hazards involved in fuel, waste, and radioisotope shipments and the methods used for protection against these hazards are considered. Federal statutes place the responsibility for safety and protection in the transport of radioactive materials on both the AEC and Department of Transportation. The responsibilities and activities performed by each agency are described. (D.H.M.)

48887 (PB–189506, pp 61–77) CONTAINERS FOR SHIPMENT OF RADIOACTIVE MATERIAL. Shappert, L. B. (Oak Ridge National Lab., Tenn.).

From Conference on the transportation of radioactive material; Charlottesville, Va. (26 Oct 1969).

In Proceedings of the conference on the transportation of radioactive material.

The types of radioactive materials for which containers must be constructed are reviewed, and some of the areas a package designer must consider in designing packaging for radioactive materials are discussed, including shielding, heat dissipation, containment, and accidental criticality in various shipping situations. (D.H.M.)

48888 (PB–189506, pp 78–81) ACCIDENT RESISTANT SHIPPING CONTAINERS FOR RADIOACTIVE MATERIAL. Sisler, James A. (Atomic Energy Commission, Washington, D. C.).

From Conference on the transportation of radioactive material; Charlottesville, Va. (26 Oct 1969).

In Proceedings of the conference on the transportation of radioactive material.

The configuration, marking, and testing of shipping containers for radioactive materials are discussed. (D.H.M.)

48889 (PB–189506, pp 82–91.A) RESPONSIBILITIES OF THE CONSIGNOR AND CONSIGNEE. Foote, Warren (General Electric Co., Pleasanton, Calif. Vallecitos Nuclear Center).

From Conference on the transportation of radioactive material; Charlottesville, Va. (26 Oct 1969).

In Proceedings of the conference on the transportation of radioactive material.

The organization and functions of a Traffic Manager engaged in shipping and receiving radioactive materials are discussed. (D.H.M.)

48890 (PB–189506, pp 92–9) RESPONSIBILITY OF THE CARRIER. Edlow, Jack (Edlow (Samuel) Traffic Management of Nuclear Materials, Washington, D. C.).

From Conference on the transportation of radioactive material; Charlottesville, Va. (26 Oct 1969).

In Proceedings of the conference on the transportation of radioactive material.

The responsibilities of the carrier of radioactive materials to regulatory bodies, the shipper, and his shareholders are discussed. (D.H.M.)

48891 (PB–189506, pp 100–6.A) SPENT FUEL SHIPMENTS: NOW AND PROJECTED. Walchli, Harold E. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Fuel Div.).

From Conference on the transportation of radioactive material; Charlottesville, Va. (26 Oct 1969).

In Proceedings of the conference on the transportation of radioactive material.

The present methods of shipping spent reactor fuels are described and the equipment requirements for future reactor fuels are considered. (D.H.M.)

48892 (PB–189506, pp 107–13) PHYSICAL PROTECTION OF SPECIAL NUCLEAR MATERIAL IN TRANSIT. Page, Ralph Gerald (Division of Nuclear Materials Safeguards (AEC), Washington, D. C.).

From Conference on the transportation of radioactive material; Charlottesville, Va. (26 Oct 1969).

In Proceedings of the conference on the transportation of radioactive material.

The physical protection of special nuclear materials in transit is discussed particularly the requirement of AEC regulations in 10 CFR Part 73. The purpose of AEC regulation in Part 73 is to protect special nuclear material in the interest of the common defense and security rather than to protect the material for health and safety reasons. The need for some clarification of Part 73 is also discussed. (D.H.M.)

48893 (PB–189506, pp 114–19) DISCUSSION OF PHYSICAL PROTECTION OF SPECIAL NUCLEAR MATERIAL IN TRANSIT. Mullaney, John F. (Division of Construction (AEC), Washington, D. C.).

From Conference on the transportation of radioactive material; Charlottesville, Va. (26 Oct 1969).

In Proceedings of the conference on the transportation of radioactive material.

The physical protection of special nuclear materials is discussed by identifying the categories of shipments made, the pattern and volume of domestic shipments of prime interest, and the criteria essential for safeguarding such shipments from diversion. (D.H.M.)

48894 (PB–189506, pp 120–5) SPECIALIZED SHIPMENTS OF RADIOACTIVE MATERIAL. Harris, Bruce D. (Nuclear Engineering Co., Inc., Morehead, Ky.).

From Conference on the transportation of radioactive material; Charlottesville, Va. (26 Oct 1969).

In Proceedings of the conference on the transportation of radioactive material.

Experiences in the radioactive waste materials transportation field are discussed that include the shipping of unusual items that required specialized handling for transportation or for which special transportation arrangements were made. (D.H.M.)

48895 (PB–189506, pp 126–40) USAEC RADIOLOGICAL ASSISTANCE PROGRAM. Zintz, F. Raymond (Division of Operational Safety (AEC), Washington, D. C.).

From Conference on the transportation of radioactive material; Charlottesville, Va. (26 Oct 1969).

In Proceedings of the conference on the transportation of radioactive material.

The policy of the USAEC radiological assistance program is to make available from AEC resources, appropriate radiological advice, and assistance needed to protect health and safety in case of incidents involving radioactive materials. The program objectives are: to establish the organization, capabilities, and procedures applicable to providing assistance and advice needed to deal effectively with either weapon or non-weapon radiological incidents, and to coordinate with other agencies in radiological assistance activities. The organization, activities, and availability of the USAEC radiological assistance teams are discussed. (D.H.M.)

48896 (PB–189506, pp 141–52) EMERGENCIES IN TRANSIT. Killian, Charles B. (New England Nuclear Corp., Boston, Mass.).

From Conference on the transportation of radioactive material; Charlottesville, Va. (26 Oct 1969).

In Proceedings of the conference on the transportation of radioactive material.

The problems that arise when there is an incident involving radioactive materials are discussed. The action taken in an actual case involving three different companies, the supplier, the transport company, and the receiving company, is reviewed. (D.H.M.)

48897 (Y-DG–1493) ACCIDENTAL LOSSES, WRITE-OFFS, NORMAL OPERATING LOSSES AND MATERIAL UNACCOUNTED-FOR. Owings, Edward (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 25 Jun 1971. Contract W-7405-eng-26. 20p. (CONF-710617–24). Dep. NTIS.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

Procedures used at the Y-12 Plant, Oak Ridge, Tenn. for fissionable material accounting are described. This plant casts enriched U metal and processes the castings into various shapes. Primary emphasis is placed on material control which requires continuous monitoring of both the material inventories and the quality of measurements used for materials accounting. Material losses are categorized as accidental losses, write-offs, normal operating losses, and Materials Unaccounted For. Methods for reducing these losses and for reporting and analyzing data on losses are discussed. (L.C.L.)

XUM

48898 CONTAINER MEANS FOR A RADIOACTIVE ELEMENT. Lecuyer, D. (to Societe Appareils Gamma-Siar AGS). Canadian Patent 871,286. 18 May 1971.

The container consists of a housing having a central compartment arranged between a pair of end compartments. The central compartment is adapted to interchangeably receive one of several different sized shielding bodies into which a radioactive element is protectively stored. The storage body is supported within a tubular housing, the opposite ends of which are mounted in corresponding counterbored recesses contained in the end walls of the central compartment. (F.S.A.) (Canada)

48899 APPARATUS FOR THE MACROGRAPHIC OBSERVATION OF METALLOGRAPHIC SPECIMENS. Blanchard, Paul; Cardon, Guy; Gicquel, Pierre; Lardillon, Serge (to Commissariat a l'Energie Atomique). French Patent 2,041,642. 18 Jan 1971. Filed 13 May 1969. (In French).

An apparatus for the macrographic observation of radioactive metallographic samples in hot cells was designed. It consists of an optical box with a means of illuminating the sample, a device for supporting the box with a means of controlling the horizontal position and height of the apparatus, and a macrographic observation bench fixed to the lower part of the box which supports the specimen and brings it into the field of observation. The mechanical movements of the apparatus, the adjusting of the support and the optical box, and the positioning of the observation bench are affected using remote control systems. (France)

48900 VENTILATED HOOD. Guignabert, Alexandre; Paillard, Robert (to Commissariat a l'Energie Atomique). French Patent 1,599,791. 20 Jul 1970. Filed 16 Oct 1968. (In French).

A ventilated hood for covering the head of an operator working in a corrosive or toxic atmosphere, especially in a medium contaminated with dusts or radioactive serosols, is described. The equipment consists of the hood itself, made of a gas-tight pliable material, closed at its upper end, and welded at its lower end to a cape which covers the shoulders. An inflatable tube is attached to the interior and is connected by means of a valve to the weakly compressed input gas. This tube contains a series of holes which maintain a pressure in the hood in excess of the external atmosphere. (auth) (France)

48901 EXEMPTIONS FROM LICENSING REQUIREMENTS FOR NUCLEAR FUELS ACCORDING TO THE ATOMIC LAW AND THE APPROPRIATE REGULATIONS. Blechschmidt, M. PTB Mitt.; No. 3, 199-201(1970). (In German).

The quantities of nuclear fuel for handling that are exempt from licensing according to Sections 6, 7, and 8 AtG, and for shipping according to Section 4 AtG, and the free quantities for covering financial securities for damages are listed. (INIS)

48902 TECHNIQUES AND MATERIALS ASSOCIATED WITH IN-PILE EXPERIMENTS. Bull. Inform. Sci. Tech. (Paris); No. 153-154, 161-4(Nov-Dec 1970). (In French).

In-pile experiments utilize various types of materials and different techniques. In the case of experiments outside the pile, cryogenic equipment is sometimes used, resulting in serious safety problems. In pile-loops and capsules are controlled using reliable devices. Hydraulic or pneumatic conveyors are used to transport very quickly or over large distances samples to or from the reactor. An advantage of pool reactors is that loops or capsules can be installed or removed without disturbing the reactor operation. Hot cell equipment was improved. The increased importance of neutronography is indicated. (France)

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 48503, 49021, 49059, 49154, 49172, 49192, 49228, 49319, 49635, 49638, 49787, 50008, 50454, 50468, 50479, 50573, 51121, and 51160.

48903 (CONF-710402-(Vol.2), pp I,172-81) TISSUE EQUIVALENT PROPORTIONAL COUNTERS IN THIN NEUTRON SHIELD STUDIES. Brackenbush, Larry W.; Endres, G. W. R.; Faust, Leo G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

Techniques for directly measuring neutron dose have become increasingly important. Tissue-equivalent proportional counter (TEPC) have been developed to make absolute neutron absorbed dose measurements, instead of calculating neutron doses from fluence and difficult neutron-spectra measurements. Exposures made with monoenergetic neutrons show that the TEPC measurements agree within about 10% of the kerma values calculated from fluence measurements. The ability of the TEPC to separate neutron and gamma doses in mixed radiation fields is demonstrated. The simple Rossi model for analysis of linear-energy-transfer distributions from TEPC data is shown to be adequate for determining quality factors from fast neutrons with energies above about 0.4 MeV. Neutron-dose-reduction measurements and quality-factor measurements are presented for various hydrogenous shields with neutrons from californium fission sources and plutonium compounds and with monoenergetic neutrons produced by accelerators. Transport computer-code calculations for the dose reduction with polyethylene shields agree within 2% of the TEPC measurements. (auth)

48904 (COO-323-18) PROGRESS REPORT. (Saint Procopius Coll., Lisle, Ill. Physical Sciences Lab.). [2 Jun 1971]. Contract AT(11-1)-323. 9p. Dep. NTIS.

The design of a high-temperature ionization chamber for ionization measurements is described, and preliminary ionization studies of mercury vapor and mixtures of argon and mercury vapor are discussed. (W.H.K.)

48905 (JAERI-Memo-4337) MEASUREMENT OF THE FAST NEUTRON FLUXES IN AN EXPERIMENTAL CRITICAL ASSEMBLY. I. FEASIBILITY STUDY OF THE DOPED GLASS DOSIMETER. Nomura, Masayuki; Yokota, R.; Imagawa, H.; Muto, Y.; Tomishima, H. (Japan Atomic Energy Research Inst., Tokyo). Jan 1971. 20p. (In Japanese). Dep. NTIS (U. S. Sales Only).

The metaphosphate glass doped with fissionable material, a kind of fission track detector, is capable of measuring monoenergetic fast neutron fluxes even at a low dose rate. The applicability of this method, however, is not confirmed yet for fast neutron fluxes having an energy distribution. A metaphosphate glass detector doped with natural uranium, depleted uranium, or thorium was prepared. With this detector, the fast neutron fluxes over an energy range were measured in the JMTRC of low power (Max. 10W) with a neutron energy distribution. The detector developed was found to be able to measure the fluxes with an accuracy of 10^6 n/cm^2 · sec ± 30% corresponding to the flux of energy over 1 MeV. (auth) (Japan)

48906 (UCRL-73295) TRITIUM STACK MONITOR WITH A WIDE DIGITAL RANGE. Silver, W. J.; Shapiro, E. G.; Greenhouse, N. A.; Scown, K. M. (California Univ., Livermore. Lawrence Radiation Lab.). [1971]. 17p. (CONF-710809-1). Dep. NTIS.

From Tritium symposium; Las Vegas, Nev. (30 Aug 1971).

A system for monitoring tritium in the stack effluent from LRL Livermore's main tritium handling facility is described. The system is composed of an ionization chamber and two scalers, one scaler for long-term recording and the other for the alarm system. (W.H.K.)

48907 LOW-NOISE PREAMPLIFIER WITH AN INPUT CATHODE FOLLOWER. Brovchenko, V. G.; Voronkov, A. E.; Kozlov, S. F.; Kuznetsov, P. A. (Inst. of Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 6, 1673-7(Nov-Dec 1970).

Translated from Prib. Tekh. Eksp.; No. 6, 112-15(Nov-Dec 1970).

A low-noise preamplifier with a cathode follower (type 6S34A tube) on the input is described which is designed to operate with diamond nuclear radiation detectors and with other semiconductor detectors having small currents and capacities. The input capacity of the preamplifier when connected to a diamond detector is 4.4 pF. The overall width of the noise curve at the half-amplitude points is 7 keV which corresponds to the resolution obtained with preamplifiers using uncooled field effect transistors (diamond detectors do not require cooling). (auth)

48908 HIGHLY SENSITIVE COUNTING SYSTEM FOR THE NANOSECOND RANGE. Zubarev, V. N.; Ivanov, V. I.; Moroz, N. S.; Radomanov, V. B.; Stavinskii, V. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 6, 1622-5(Nov-Dec 1970).

Translated from Prib. Tekh. Eksp.; No. 6, 68-71(Nov-Dec 1970).

Blocks of fast nanosecond equipment designed for operation from the current pulse of a photomultiplier at the level of one photoelectron over a wide dynamic range are described. The system contains the following functional blocks: a device for shaping the photomultiplier pulses, a mixer-amplifier, a multiplier, a nonlinear mixer, and coincidence circuits with anticoincidences. The intrinsic rise time of each block does not exceed 1.2 nsec. The input resistance is 50 Ω. The polarity of the pulses is negative. Direct coupling is used throughout. The coefficient of temperature instability of the zero level is 1 mV/°C. (auth)

48909 HIGH-STABILITY NANOSECOND COINCIDENCE CIRCUIT FOR SLOW NaI(Tl) SCINTILLATORS. Bonyushkin, E. K.; Drozdov, Yu. M.; Spektor, V. V.; Orlov, R. A. Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 6, 1626-9(Nov-Dec 1970).

Translated from Prib. Tekh. Eksp.; No. 6, 72-5(Nov-Dec 1970).

A high-stability nanosecond coincidence circuit (2τ = 15 nsec for triple coincidences at a 100% efficiency of registration) for operation with slow NaI(Tl) scintillators is described. The bipolar shaping of the input current pulse and an amplifier-limiter with a null detector using a tunnel diode give a high time and temperature stability. Moreover, the maximum time shift in the synchronization circuit is ~3 nsec in the dynamic amplitude range of the input pulse equal to 25. When the environmental temperature changes from −5 to +40°C, the time shift in the synchronization circuit does not exceed 1 nsec. (auth)

48910 DETERMINING THE THICKNESS OF THE MICA ENTRANCE WINDOW OF AN END COUNTER FROM THE SCATTERED BETA RADIATION. Polyukhov, V. G.; Gavrilov, V. D.; Popov, Yu. S.; Chetverikov, A. P. Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 6, 1584-6(Nov-Dec 1970).

Translated from Prib. Tekh. Eksp.; No. 6, 37-8(Nov-Dec 1970).

A simple method is described for determining the thickness of the mica entrance window of an end counter without destroying this window. The method is based on the single-valued dependence of the intensity of the scattered β radiation on the thickness of the scattering material. The thickness of the mica entrance windows of end counters measured in a lot of eight counters deviated by no more than 8% from the thickness found by weighing. (auth)

48911 SCINTILLATION COUNTERS BASED ON THE FEU-49 PHOTOMULTIPLIER WITH PULSED POWER SUPPLY. Grishkov, V. A.; Kazakevich, G. M.; Filippov, E. M. (Inst. of Geology and Geophysics, Novosibirsk, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 6, 1590-1(Nov-Dec 1970).

Translated from Prib. Tekh. Eksp.; No. 6, 41-2(Nov-Dec 1970).

The possible design of scintillation neutron counters based on the FÉU-49 photomultiplier with pulsed power supply has been studied. Stabilitrons are used as dividers in the dynode circuit of the photomultiplier. It is shown that this system permits a highly efficient control of the photomultiplier gain. The amplitude characteristics of the detectors have been measured, as has the gain recovery time of the FÉU-49 with a pulsed power supply. (auth)

48912 MATHEMATICAL MANIPULATION OF MULTIPARTICLE NUCLEAR REACTIONS. Linetskii, A. R.; Makarovskii, E. L.; Rutkevich, N. Ya. (Physical-Technical Inst., Kharkov). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 6, 1602-5(Nov-Dec 1970).

Translated from Prib. Tekh. Eksp.; No. 6, 52-4(Nov-Dec 1970).

The software accessories of the "Archimedes" microscope for measuring nuclear emulsions, and the program for the manipulation of experimentally obtained data are described. The reactions involved in the partial and complete disintegration of light nuclei into α-particle fragments were studied, which occur in thick-layered nuclear emulsions after irradiation with α particles having an energy ~38 MeV. (W.H.K.)

XUM

48913 ^{14}N PROPORTIONAL COUNTER FOR USE IN RADIOBIOLOGY. Frigerio, N. A.; Coley, R. F. (Argonne National Lab., Ill.). Nucl. Instrum. Methods; 95: No. 2, 381-3(1971).

A simple proportional counter is described which utilizes the $^{14}N(n,p)$ and $^{14}N(n,\alpha)$ resonances and the thermal neutron $^{14}N(n,p)$, $^{10}B(n,\alpha\gamma)$, and $^{10}B(n,\alpha)$ reactions for neutron energy calibrations in radiobiology. Experimental results are presented for $^{7}Li(p,n)$ calibrations at proton energies of 1882, 2362 and 3093 keV. (auth)

48914 SYSTEM FOR ELIMINATING RANDOM EVENTS FROM PULSE-HEIGHT COINCIDENCE SPECTRA. Beattie, R. J. D.; Byrne, J. (Univ. of Sussex, Brighton, Eng.). Nucl. Instrum. Methods; 95: No. 2, 373-5(1971).

A technique is described for simultaneously recording true-plus-random and random spectra in $\beta-\gamma$ coincidence measurements. (auth)

48915 DIRECTIONAL CHARACTERISTICS OF CYLINDRICAL SCINTILLATORS. Petr, I.; Adams, A.; Birks, J. B. (Univ. of Manchester, Eng.). Nucl. Instrum. Methods; 95: No. 2, 253-7(1971).

The general analytical solution is presented for the detection cross section, efficiency, and directivity of a cylindrical scintillator irradiated by a gamma-ray source located off the axis. The calculated parameters for a cylindrical scintillator are compared with those for a cuboidal scintillator, which represents a useful approximation, and with the experimental parameters. The properties of a scintillator irradiated by nonmonoenergetic photons and by an isotropic radiation field are discussed. (auth)

48916 SPECIAL TYPE MULTIWIRE COUNTER FOR PARTICLE DETECTION AND IONISATION MEASUREMENT. Borer, K.; Czapek, G.; Kaspar, H.; Seiler, P. G. (Univ., Bern). Nucl. Instrum. Methods; 95: No. 2, 285-7(1971).

A "massless" particle detector is developed. It is a multiwire counter, in which all counting wires are connected to the same preamplifier. It has a low stopping power and a good efficiency. Counters of this kind can be made with large sensitive areas for a fairly low price. They are useful as trigger or hodoscope counters, in particular, for the detection of low-energy particles. Measuring the primary ionization in the counter as a function of particle momentum or residual range yields information helpful for particle separation. (auth)

48917 DETECTION OF THE PLANE OF POLARIZATION OF LINEARLY POLARIZED PHOTONS WITH A RECTANGULAR GEOMETRY Si(Li) DETECTOR. Logan, B. A. (Univ. of Ottawa). Nucl. Instrum. Methods; 95: No. 2, 301-5(1971).

The polarization sensitivities of some rectangular-geometry lithium-drifted silicon detectors have been calculated under the assumption of 100-keV and 300-keV linearly polarized photons. The calculations show that silicon detectors are suitable for determining the plane of polarization of low-energy photons. The relative merits of several commercially available detectors are discussed. (auth)

48918 WALK REDUCTION IN TIMING CIRCUITS THROUGH AMPLITUDE INFORMATION. Abbattista, N.; Marangelli, B.; Plantamura, V. L. (Istituto di Fisica, Bari, Italy). Nucl. Instrum. Methods; 95: No. 2, 327-31(1971).

A method is presented for time-variance reduction, in high-speed timing circuits, that exploits the amplitude information of the individual signals. An experimental circuit to test the method effectiveness is also shown. (auth)

48919 EFFICIENCY DISTRIBUTION ASSOCIATED WITH NEON FLASH TUBES. Hampson, H. F.; Rastin, B. C. (Univ. of Nottingham, Eng.). Nucl. Instrum. Methods; 95: No. 2, 345-8(1971).

Flash tube data can be objectively analyzed using a computer in the manner described by Bull et al. [Nuovo Cim., Suppl., 23: 28(1962)]. The analysis technique depends upon the knowledge of the variation of the probability of the tube's flashing with distance of the trajectory from the tube center. This is termed the $P(\theta)$ distribution and is the subject of the present investigation. $P(\theta)$ distributions were measured for tubes of diameter 0.59 cm filled to 1, 2.5, and 3 atm pressure. A theoretical model which assumes that the only loss of electrons is by thermal diffusion to the tube walls and attachment to oxygen molecules enables similar distributions to be calculated, and these are in agreement with experiment. (auth)

48920 GEL FOR LIQUID SCINTILLATION COUNTING BASED ON BITOLYLENE DIISOCYANATE. Lieberman, R.; Williams, M. W.; Pepper, E. W. (Southeastern Radiological Health Lab., Montgomery, Ala.). Health Phys.; 21: No. 2, 326-7(Aug 1971).

An improvement has been made in the methodology for making gels used in liquid scintillation counting. The gel is based on the reaction product between bitolylene diisocyanate, Isonate 136-T and Armeen L-11 (branched aliphatic primary amine). The diisocyanate used has moderate reactivity and low vapor pressure. Gelling consistency and time can be varied with the concentration of diisocyanate dissolved in the scintillation solution. (UK)

48921 NATURE OF THE PHOTOGRAPHIC EFFECT OF IONIZING RADIATION. Bogomolov, K. S. Usp. Nauch. Fotogr.; 15: 67-77(1970). (In Russian).

A variety of photographic plates for nuclear application are currently manufactured in the Soviet Union, for use in high-energy physics, mass spectrography and charged-particles studies. The mechanism occurring in the emulsion is described primarily on the basis of the pertinent Soviet research. Formation of the latent image involves first the direct interaction of the primary and secondary ionizing radiations with the matter of the emulsion, resulting in the formation of conductivity electrons, and secondary processes which include all subsequent steps, culminating in the latent image. Studies have been made to clarify these steps by exposing the emulsion to x radiation at 20°C and at −186°C; the results revealed that the various stages agree with those observed when the emulsion is exposed to visible radiation. The formation of conductivity electrons from large silver halide grains exposed to ionizing radiation has been confirmed by lattice structure studies. Novel nuclear emulsions have been derived by varying the parameters, such as silver halide concentration, the grain size, conditions of maturing of the emulsion, and the development. The dimensions of the latent image centers were determined directly by N. P. Kocherov et al. who measured the intensity ratio of the γ lines of ^{108}Ag and ^{198}Au; they found that these centers amount to about 10^3 Ag atoms in case of exposure to the α particles of plutonium. (74 references) (TTT)

48922 PHOTOGRAPHIC METHOD IN NUCLEAR PHYSICS. Perfilov, N. A. Usp. Nauch. Fotogr.; 15: 52-66(1970). (In Russian).

Thick, specially prepared photographic emulsions, which are sensitive toward nuclear radiations (charged particles), have been widely used to study nuclear phenomena. The fast charged particles—electrons, deuterons, α particles or ionized atoms, passing through the emulsion layer transform part of the AgBr grains which may be selectively developed; this makes it possible to follow the track of the particle under the microscope. The currently available emulsions are so sensitive that they are able to record very low-energy particles with a sufficiently high photographic density. The "thick-layer" method was initiated by L. V. Mysovskii and P. I. Chizhov who recorded the α particles originating from the decay of RaC'. Several Soviet institutes, such as the Radium Institute, the Institute of Atomic Energy, The Motion Picture Institute and the State Optical Institute have made contributions to the development of nuclear emulsions. The emulsion plays a dual role in experiments: it serves as a detector and as a target. Three dimensional phenomena are recorded with very thick supportless emulsions; new methods of development have been perfected to avoid distortion in any of the 3 dimensions. The sensitivity, grains size, and other characteristics of currently available nuclear emulsions are listed, describing currently used and proposed applications of the photographic method. (39 references) (TTT)

48923 APPARATUS FOR TRITIUM MEASUREMENTS IN COINCIDENCE SCHEME. Blaszczak, Z.; Gradys, S.; Krotowicz, J. (Osrodek Badawczy Techniki Geologicznej, Warsaw). Tech. Poszukiwan; 6: No. 23, 56-9(1967). (In Polish).

The construction of a simple instrument to measure tritium activity by means of a coincidence scintillation method is discussed, and application of this instrument in measuring the activity of tritium used in hydrogeological researches is described. (auth) (NSA of Poland)

48924 TWO-DIMENSIONAL SCANNER FOR RADIOCHROMATOGRAMS EMPLOYING AN ELECTRON MULTIPLIER DETECTOR IN VACUO. Prydz, S.; Meloe, T. B.; Koren, J. F. (Univ. of Oslo). J. Chromatogr.; 59: No. 1, 99-119(8 Jul 1971).

A step scanner for the measurement of both one- and two-dimensional distributions of radionuclides in paper or thin-layer chromatography has been constructed and tested. Different versions of a miniaturized channel electron multiplier have been applied as detectors. A description is given of the principle of operation for this detector type, the vacuum scanner, and the way of data presentation. Performance tests have been made with calibrated standards of ^{3}H and ^{14}C in the form of poly(methyl methacrylate) pieces with known electron emission defined as the number of electrons emitted per second per cm^2. Several thin-layer media have been used, mostly with directly applied spots of [^{3}H]- or [^{14}C]

glucose solutions. Upon drying, spots of activities down to 5 nCi could easily be detected (spot areas were approximately 0.7 cm^2). A resolution of 1 mm could easily be achieved in the one-dimensional scans. Some more results of a somewhat preliminary nature are reported. Some possible alternatives for the recording of measurements which use the channel electron multiplier detector are mentioned. The use of scanning by electron multipliers as a method for radiochromatography has the advantages that the sample is neither damaged nor contaminated compared with conventional techniques which, for example, employ the admixture of wet (or dry) scintillators. It is felt that these advantages for certain applications more than compensate for the fact that the technique requires a vacuum of $5 \cdot 10^{-4}$ torr. (auth)

48925 AUTOMATION OF LIQUID SCINTILLATION DATA PROCESSING. Reich, A. R. (Merck Sharp and Dohme Research Labs., Rahway, N. J.). J. Radioanal. Chem.; 6: No. 2, 437-45 (Dec 1970).

A program was written in the Basic language to handle scintillation counting data by a time-sharing computer. Explanation is given for the use of the program to facilitate the most common types of calculations, as well as the automatic data handling between the spectrometer and the remote computer. The merits of the system are discussed and a sample of the operation and the output is given. (auth)

48926 COINCIDENCE RESOLVING TIME OF LARGE COAXIAL Ge(Li) DETECTORS. Ryge, P.; Borchers, R. R. (Univ. of Wisconsin, Madison). Nucl. Instrum. Methods; 95: No. 1, 137-40(1971).

Large volume coaxial Ge(Li) detectors have poor timing properties due to the slow and widely varying pulse shapes. To investigate the influence of detector geometry and the effectiveness of timing techniques, wide and narrow dynamic range time resolution measurements were made for three shapes of high efficiency detectors using four timing methods. The resolution obtained with true coaxial detectors was about a factor of two better than the others. Timing methods which attempt to compensate for pulse shape variations were substantially better than leading edge discrimination, especially for wide dynamic range. (auth)

48927 PULSE SHAPE DISCRIMINATION IN INORGANIC AND ORGANIC SCINTILLATORS. I. Winyard, R. A.; Lutkin, J. E.; McBeth, G. W. (Brighton Polytechnic, Eng.). Nucl. Instrum. Methods; 95: No. 1, 141-53(1971).

The zero crossing technique of pulse shape discrimination (P.S.D.) has been employed to study the P.S.D. properties of a wide range of organic and inorganic scintillators. A figure of merit for P.S.D. has been defined and the relation between the figure of merit and particle rejection ratios is indicated. Results are presented which indicate the effect of dynamic range on discrimination. The excellent P.S.D. properties of CsI(Na) are also discussed. (auth)

48928 NEUTRON DETECTOR WITH FLAT RESPONSE UP TO 50 MeV. Costa, S.; Ferrero, L.; Pasqualini, L. (Univ., Turin). Nucl. Instrum. Methods; 95: No. 1, 155-61(1971).

The efficiency of a neutron detector with two rings of BF_3 counters embedded in paraffin was calculated by means of a Monte Carlo technique up to 50 MeV neutron energy. The results show that the efficiency is nearly constant (within ±6%) over the entire range of neutron energies explored. The possibility of using a detector of this type as a low-resolution spectrometer is discussed as well as the electronics associated with the detector itself. (auth)

48929 PILE UP REJECTION BY COMPARISON OF THE SHAPED PULSE WITH ITS SECOND DERIVATIVE. Sabbah, B. (Elscint Ltd., Haifa, Israel); Klein, I.; Arbel, A. Nucl. Instrum. Methods; 95: No. 1, 163-71(1971).

A pile up rejector is described for use in a high resolution nuclear spectrometer operating at high counting rates. The principle of pile up rejection described is based upon the "pile up inspection signal," which is obtained by a summation of the shaped pulse and its second derivative. If the summation is performed with the proper constant of proportionality, then the sensitivity to pile up is independent of the amplitude of the pulse under scrutiny. It is a function only of the delay between that pulse and the one causing pile up, and of the latter's amplitude. An expression has been derived for ideal Gaussian shaping, defining the amplitude and delay of those pile-up pulses which introduce a certain minimum error in measuring the pulse under scrutiny. The graph thus obtained provides a criterion for the performance comparison of pile up rejectors employing various kinds of shaping. Results are presented, which were obtained with a practical system employing nea Gaussian shaping. (auth)

48930 DETECTION METHOD FOR GAMMA-RAY ASTRONOMY RESEARCHES UP TO 0.4 MeV. Brini, D.; Di Cocco, G. (CNR, Bologna). Nucl. Instrum. Methods; 95: No. 1, 181-8 (1971).

The principle of a detector method considered for applications in gamma-ray astronomy for energies up to about 0.4 MeV is described. The basic idea is to minimize the contribution of the Compton signals in the detected spectrum using responses of scintillators with different Z values. Thus the signal spectrum should correspond, independently of the peak efficiencies, to the photon spectrum. This idea was applied to the design and study of an effective and relatively cheap detection system having directional properties and a low measurable instrumental background. The laboratory tests and the obtained characteristics of this spectrum are reported, together with the suggested complete operational mode which is applied, as an example, to the measurement of the local diffuse gamma rays. (auth)

48931 LARGE AREA GAS CHERENKOV TELESCOPE FOR HIGH-ENERGY GAMMA-RAY ASTRONOMY. Albats, P. (Cornell Univ., Ithaca, N. Y.); Ball, S. E.; Delvaille, J. P.; (and others). AF-AFOSR-255-67. Nucl. Instrum. Methods; 95: No. 1, 189-94 (1971).

In order to achieve a major advance in the sensitivity of detectors for high energy gamma-ray astronomy, a new type of detector, a large area gas Cherenkov telescope suitable for use on balloons and satellites, was developed. This detector has a collection area of almost 5 m^2 and the capability of significantly lowering the flux limits from gamma ray sources. (auth)

48932 GEOMETRICAL FACTOR AND DIRECTIONAL RESPONSE OF SINGLE AND MULTI-ELEMENT PARTICLE TELESCOPES. Sullivan, J. D. (Univ. of Chicago). Nucl. Instrum. Methods; 95: No. 1, 5-11(1971).

After a general treatment of the gathering power of particle telescopes, exact formulas are presented for the geometrical factor and directional response of multi-element cylindrically symmetric telescopes with circular or rectangular cross sections. Some useful approximations to those formulas are given. For the gathering power in arbitrary geometries, there is a discussion of applicable digital computer techniques focusing particularly on a Monte-Carlo method. (auth)

48933 TRIAL MANUFACTURE AND THE CHARACTERISTICS OF IONIZATION CHAMBER FOR THE COUNTING β, γ-RAYS. Kim, Yong Hee; Han, Joon Taik; Yook, Chong Chul. Hanyang Univ. Res. Works Grad. Sch.; 5: 148-60(1969).

The ion current caused within the ionization chamber was theoretically investigated and analyzed for the trial manufacture of a parallel plate air ionization chamber, and subsequently a current type amplifier required was made. The testing ionization chamber manufactured was compared with the standard ionization chamber Cutie pie survey meter available at the Atomic Energy Institute. The sources used for the comparison were 200mCi $^{90}Sr-^{90}Y$, bremsstrahlung x-ray device, 0.4mCi ^{60}Co, 13.7mCi ^{226}Ra, 45mCi ^{60}Co and 100mCi $^{90}Sr-^{90}Y$. As a result of the experiment, a closer linearity was observed to be coincident with the theory between the ion current measured in the testing chamber and the Cutie pie survey meter. The experiment on the relationship between the ion current and distance measured in the testing chamber revealed also that the values of experiment and theory were well fit for long distances, while a smaller ion current than the theoretical value was measured in a short distance. (Korean Sci. Abstr.)

48934 LINAC X-RAY AND ELECTRON DOSIMETRY USING A REMOTE CONTROL PIN DIODE. Friedman, J. D. (Air Force Cambridge Research Labs., Bedford, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 736-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A remotely positioned PIN diode was built and has been used for x-ray and electron beam dosimetry. The dose rate is read directly on an oscilloscope and the position is read on a digital voltmeter. The diode has been calibrated with TLDs (^{60}Co). Agreement is within 5% over three orders of magnitude. The data for a plot of dose vs. distance (1 meter) can be obtained for 40 or 50 data points in a few minutes. Measurements, using an assortment of beam degraders, have been done using the diode scanner and remotely controlled target changing wheel. These data can, in turn, be used for rapid predetermined changes in the LINAC dose rate without retuning the accelerator. Several diodes having different thickness absorbers are used depending on the sensitivity desired. These absorbers can be tailored to simulate the shielding of an experimental device. The PIN diode response then gives a good approximation of the actual absorbed dose. Additionally, varying the absorber material to approximate that of a test device facilitates making a correspondence between absorbed doses received from different radiation sources. (auth)

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48935 DESIGN AND APPLICATIONS OF LOGARITHMIC ENCODERS. Gsponer, A. (CERN, Geneva). Nucl. Instrum. Methods; 96: No. 1, 21-7(1971). (In French).

Two fast and cheap logarithmic encoders are described. In a range of 40 dB they are linear within a precision of less than 3% in a gated mode or not. Several applications are suggested: distributed measurement with proportional chambers, particle identification, and mass discrimination with Cherenkov counters. (auth)

48936 DENSITY EFFECT AND RATE OF ENERGY LOSS IN COMMON PLASTIC SCINTILLATORS. Paul, J. M. (Louisiana State Univ., Baton Rouge). Nucl. Instrum. Methods; 96: No. 1, 51-9(1971).

The density effect term in the rate of ionization energy loss formula has been determined for common types of plastic scintillator following the well-known dispersion model of Sternheimer. The rate of energy loss and the most probable energy loss in thin detectors made of plastic scintillator have been calculated and tabulated systematically taking into consideration both density effect and shell correction terms. The values of fwhm as percentage of the most probable energy loss in detectors of three different thicknesses have been calculated and presented graphically covering the range of interest in both high energy physics and cosmic rays. (auth)

48937 GAMMA INSENSITIVE AIR MONITOR FOR RADIOACTIVE GASES. Jalbert, R. A.; Hiebert, R. D. (Los Alamos Scientific Lab., N. Mex.). Nucl. Instrum. Methods; 96: No. 1, 61-6(1971).

A flow-through, ionization-chamber type air sampler for radioactive gases is described. Gamma compensation is achieved by the usual addition of a sealed chamber. However, the two chambers, identical in other respects, orbit about a common axis, thereby occupying the same space in each revolution. Gamma subtraction is thus more effectively achieved than with stationary chambers in areas where external gamma fields are nonuniform or may change spectrally or directionally. The detection limit for radioactive gases in the presence of gamma background is imposed by the subtraction of two large quartities, each of which has statistical fluctuations. Using one-liter chambers, and an electrometer amplifier with a full-scale sensitivity of 10^{-13} A and a 50-second time constant, a 50 mR/h gamma exposure rate results in fluctuations corresponding to a standard deviation of approximately 3×10^{-15} A. In the case of tritium sampling (full scale $\approx 140\ \mu Ci/m^3$), the detection limit in the same gamma field is less than 10 $\mu Ci/m^3$ after several minutes of observation. (auth)

48938 DETERMINATION OF THE EFFICIENCY OF A WELL-TYPE NaI(Tl) CRYSTAL CONSIDERING SCATTERING OUTSIDE THE CRYSTAL. Christmann, B. (Freie Univ., Berlin). Nucl. Instrum. Methods; 96: No. 1, 67-75(1971). (In German).

The efficiency of a $1\frac{3}{4}$'' diam. × 2'' NaI(Tl)-crystal with a well of $^{21}/_{32}$'' diam. × $1^{35}/_{64}$'' is determined for an aqueous ^{137}Cs-solution (1 ml). Using this measurement as an example, different methods are shown for taking into account the increase of counting rates by outside scattering. The efficiency values are corrected with respect to the effects of scattered quanta; they are in good agreement with calculated values. The experimentally determined peak/total-ratio surpasses by 7% the values of Snyder's Monte-Carlo calculations. (auth)

48939 POSITION SENSITIVE GEIGER COUNTER. De Lima, J. J. P.; Pullan, B. R. (Univ. of Manchester, Eng.). Nucl. Instrum. Methods; 96: No. 1, 77-9(1971).

The position of a detected ionizing particle in a Geiger counter is determined by measuring the arrival times of an avalanche at the two ends of the counter. The design of a Geiger counter and associated electronics is described. The system is capable of a position resolution of 0.4 cm and a stability of 1% in position measurement provided the voltage on the counter, the pressure and temperature are stabilized. (auth)

48940 NEW TYPE OF NON-INJECTING BACK CONTACT FOR TOTALLY DEPLETED SILICON SURFACE BARRIER DETECTORS. England, J. B. A.; Hammer, Vera W. (Univ. of Birmingham, Eng.). Nucl. Instrum. Methods; 96: No. 1, 81-3 (1971).

A new rugged and versatile back contact for silicon surface barrier detectors using an evaporated germanium layer is described. Brief details of the manufacturing process are given, and some typical counter characteristics are shown. Some of the additional peculiar properties of this new contact are described, and its performance is compared with main types of contact currently used. (auth)

48941 ABSOLUTE MEASUREMENT OF THE EFFICIENCY OF A BF_3 PROPORTIONAL COUNTER. Sampson, T. E.; Vincent, D. H. (Univ. of Michigan, Ann Arbor). Nucl. Instrum. Methods; 95: No. 3, 563-9(1971).

An absolute measurement of the efficiency of a BF_3 counter in narrow beam geometry in the energy range from 0.024 eV to 0.111 eV is reported. Agreement with calculated efficiency values is excellent. No significant end effects are noted. The basic feature of this experiment is the measurement of the incident neutron flux by gold foil activation and counting in an NaI well counter which was calibrated with gold foils irradiated in the National Bureau of Standards Standard Thermal Neutron Flux. (auth)

48942 TOTAL ABSORPTION IONIZATION CHAMBER FOR 1.5 TO 10 keV X RAYS. Lyons, P. B. (Los Alamos Scientific Lab., N. Mex.); Baran, J. A.; McCrary, J. H. Nucl. Instrum. Methods; 95: No. 3, 571-83(1971).

The design of a xenon gas ionization chamber is presented. Corrections to energy fluence measurements were considered. The correction for escape of xenon fluorescent L X rays was measured with a xenon-methane proportional counter. The chamber was compared to a Si(Li) detector and an argon-methane proportional counter over the energy range from 1.7–10.5 keV. The chamber was shown to be accurate to ±2%, independent of uncertainties in entrance window transmissivity. Overall chamber accuracy is ±3%. The useful energy fluence rate range for the chamber was shown to be from below 10^{-11} to 5×10^{-5} W/cm^2. A value of 21.5 ± 0.4 eV for the mean energy per ion pair in xenon was obtained from the measurements. A chamber useful up to 35 keV could be constructed without accuracy degradation by an increase in chamber size. (auth)

48943 INVESTIGATION OF POSSIBLE SYSTEMATIC ERRORS IN THE $\bar{\nu}$ MEASUREMENTS WITH A LARGE Gd-LOADED LIQUID SCINTILLATOR. Signarbieux, C.; Ribrag, M.; Poitou, J.; Matuszek, J. (CEN de Saclay, Gif-sur-Yvette, France). Nucl. Instrum. Methods; 95: No. 3, 585-8(1971).

An experimental method checking the reliability of $\bar{\nu}$ measurements has been tested. Results lead to a σ_f^2 value for ^{252}Cf lower than those published by others. The so-called ''French effect'' is investigated as a function of the scission mode. (auth)

48944 USE OF CASCADED CHANNEL PLATES AS HIGH GAIN ELECTRON MULTIPLIERS. Parkes, W.; Gott, R. (Univ. of Leicester, Eng.). Nucl. Instrum. Methods; 95: No. 3, 487-91(1971).

Details are presented of the experimental arrangement and operation of channel plates used in cascade. The important characteristics are a high gain, of the order of 10^7, and a peaked pulse height distribution. The effect of ion feedback, high count rate performance and gain-voltage characteristics are discussed with a view to establishing the feasibility of the use of such a device in a rocket or satellite environment. (auth)

48945 READOUT SYSTEM FOR WIRE PROPORTIONAL CHAMBER BY MEANS OF A MAGNETOSTRICTIVE DELAY LINE. Bertin, P. Y.; Planchard, E. J. (Univ., Clermont-Ferrand, France). Nucl. Instrum. Methods; 95: No. 3, 493-6 (1971). (In French).

Each wire of the proportional chamber is terminated by a small coil surrounding magnetostrictive delay line. The time delay taken by the mechanical stress to reach a reading coil is digitalized. The electronic system is described. An 8-wire chamber has been tested in line with a Varian 620 i computer. (auth)

48946 DETERMINATION OF THE TOTAL DETECTION EFFICIENCY OF A WELL-TYPE NaI(Tl) CRYSTAL FOR γ-SOURCES EMITTING IN COINCIDENCE. Christmann, B. (Freie Univ., Berlin). Nucl. Instrum. Methods; 95: No. 3, 541-4(1971). (In German).

Using extended ^{22}Na and ^{60}Co sources as an example it is shown, how well-type scintillation crystals can be calibrated for the determination of activities from the total counting rate without using comparative sources. The efficiencies are calculated from the attenuation coefficients considering angular correlations. The effects of the angular correlations are small for source points far from the well hole. For many practical cases the efficiencies can be determined from the absolute total efficiencies of point sources tabulated by other authors. (auth)

48947 PULSE SHAPE DISCRIMINATION TECHNIQUE IN A CsI(Tl) CRYSTAL FOR THE DETECTION OF ENERGETIC NEUTRONS. D'Cunha, M. F.; Joseph, G. (Tata Inst. of Fundamental Research, Bombay). Nucl. Instrum. Methods; 95: No. 3, 515-20(1971).

A method of identifying energetic neutrons, in the presence of low energy gamma rays, by the pulse shape discrimination technique in a CsI(Tl) crystal is described. Such a system is useful in the study of energetic neutrons and gamma rays in the atmosphere. The pulse shape discrimination circuit developed for this

purpose and the performance of the neutron detector incorporating the circuit in a balloon flight is presented. (auth)

48948 LIQUID ARGON IONIZATION CHAMBER. Deshpande, R. Y.; Ramanna, R. (Bhabha Atomic Research Centre, Trombay, India). pp 2x51-5 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

48949 ENERGY BALANCE METHOD FOR PULSE SHAPE DETERMINATION IN SOLID-STATE IONIZATION CHAMBERS. Deshpande, R. Y. (Bhabha Atomic Research Centre, Trombay, India). pp 256-9 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 50030, 50615, and 50775.

48950 (AD-718142) X-RAY DETECTION IN SEMICONDUCTORS AND SCINTILLATORS. Final Report. Aitken, Donald W. (Stanford Univ., Calif. High-Energy Physics Lab.). Jan 1971. Contract F44620-69-C-0042. 8p. (AFOSR-TR-71-2). NTIS.

The broad objectives of the program were to carry to conclusion a long-term (six-year) research program on the properties of silicon and germanium and alkali-halide scintillation detectors as x-ray detectors; to expand knowledge about these kinds of materials; and to increase opportunity for practical applications. A particular application that was studied in detail involved the construction and flight of a prototype germanium spectrometer for x-ray observations in space physics. The work performed and the new directions and applications that resulted from the work are summarized, and it is concluded that the objectives of the originally proposed research were satisfactorily accomplished. (auth) (USGRDR)

48951 (ARH-1877) SYSTEMATIC PEAK REDUCTION METHOD FOR SEMICONDUCTOR DETECTOR SPECTRA. Zimmer, W. H. (Atlantic Richfield Hanford Co., Richland, Wash.). 15 Jan 1971. 20p. Dep. NTIS.

A systematic method of data reduction for peaks obtained with semiconductor detectors has been developed. The method is designed for general analytical application and is easily programmed for utilization with small computers. The representative area of a spectral peak is established on the basis of the detector system resolution and the noise continuum level on each side of the peak, the latter being determined by a simple search routine. Specific comparisons of accuracy and precision are made to the "Total Photopeak" method of data reduction. (auth)

48952 (ARH-1993) Ge(Li) IV ^{239}Pu PACKAGE COUNTER. Zimmer, William H. (Atlantic Richfield Hanford Co., Richland, Wash.). Mar 1971. Contract AT(45-1)-2130. 26p. Dep. NTIS.

The Ge(Li) IV is a passive plutonium-239 package counter system capable of detecting and quantitatively analyzing a wide weight range of plutonium-239 in any standard Hanford waste container in compliance with and exceeding waste disposal objectives of less than eight microcuries plutonium-239 per kilogram ±30% at the 95% confidence level. The packages are rotated and oscillated, and the package radiation columnated to compensate for nonhomogeneity. An external radiation source emission is passed through the packages to provide data for radiation self-absorption compensation. Four coaxial Ge(Li) detectors are employed to provide a large area of detecting surface. The 413.7 keV gamma emission of plutonium-239 from within the package and the 355.3 keV gamma emission of an external barium-133 source are pulse-height analyzed and data-reduced under computer program control; the computer reads out grams of plutonium-239 in the package, the computed self-absorption correction, and the precision at the 95% confidence level of both values. The Ge(Li) IV system and its performance are described. (auth)

48953 (CONF-710402-(Vol.3), pp III.1-6) BOREHOLE SONDE USING A ^{252}Cf SOURCE AND A Ge(Li) DETECTOR COOLED BY A MELTING CRYOGEN. Tanner, Allan B.; Moxham, Robert M.; Senftle, Frank E. (Geological Survey, Washington, D. C.); Baicker, Joseph A. (Princeton Gamma-Tech., Inc., N. J.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

A sonde was built for high-resolution measurement of natural or neutron-induced gamma rays in boreholes. The sonde is 7.3 cm in diameter and about 2.2 m in length and weighs about 16 kg. The lithium-compensated germanium semiconductor detector is stabilized at −188°C for as much as ten hours by a sealed cryostatic reservoir containing melting propane. During periods when the sonde is not in use the propane is kept frozen by a gravity-fed trickle of liquid nitrogen from a reservoir temporarily attached to the cryostat section. A ^{252}Cf source, shielded from the detector, may be placed in the bottom section of the sonde for analysis by measurement of neutron-activation or neutron-capture gamma rays. Stability of the sealed cryostat with changing hydrostatic pressure, absence of vibration, lack of need for power to the cryostat during operation, and freedom of orientation make the method desirable for borehole, undersea, space, and some laboratory applications. (auth)

48954 (CONF-710402-(Vol.3), pp III.43-7) ^{252}Cf NEUTRON INDUCED RADIATIVE CAPTURE GAMMA RAYS FOR HIGH ENERGY DETECTOR CALIBRATION. Trombka, Jacob I.; Eller, E.; Oswald, G. A. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center); Berger, M. J.; Seltzer, S. M. (National Bureau of Standards, Washington, D. C.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

High-energy gamma-ray sources produced by prompt-neutron radiative capture were developed in order to study the variation of pulse height, the shape of pulse-height distribution, and resolution as a function of energy for scintillation detectors. The system as described was also used to calibrate the gamma-ray spectrometers flown aboard Apollo 15 and 16. Spectral distribution of gamma rays in the 3 to 12 MeV energy region were studied for a number of nuclear species by using a 3 in. × 3 in. NaI(Tl) detector. Elements studied were nickel, with lines at 8.999 and 8.533 MeV; Mercury, with lines at 5.967, 4.842, 4.740, and 3.289 MeV; and Hydrogen, with a line at 2.223 MeV. The neutron excitation of these samples was carried out by placing these samples in a neutron moderator near a ^{252}Cf source (~2 μg). Methods for inferring photon spectra from the pulse-height spectra were developed for use in interpreting the gamma-ray measurements carried out during the Apollo 15 and 16 flights. Detailed knowledge of the response of the flight detectors as a function of energy is required to perform the analysis. In the energy region above 3 MeV, it is extremely difficult to obtain response functions for truly monoenergetic gamma rays. Therefore, the following approach was taken: Monte Carlo calculations were carried out to determine the nature of these response functions in the 3 to 12 MeV region. These spectra are compared with the experimentally determined spectra obtained using the ^{252}Cf system described above. These comparisons form a basis for predicting the shape of the pulse-height spectrum for gamma rays of any energy in this range. (auth)

48955 (COO-2049-3) INTERCALIBRATION OF THE KSU NE-213 FAST-NEUTRON SPECTROMETER SYSTEM. Meyer, Walter; Thiesing, James W.; Estes, C. Michael (Kansas State Univ., Manhattan. Dept. of Nuclear Engineering). 19 Dec 1970. Contract AT(11-1)-2049. 50p. Dep. NTIS.

Using a PoBe source and standard geometry supplied by ORNL (Source PN-19) a one hundred twenty (120) minute complex neutron spectrum was measured with the KSU NE-213 neutron spectrometer. The complex spectrum was unfolded with the ORNL code FERDOR. The KSU FERDOR result is compared with ORNL measurements made with the same PoBe source and also unfolded with the FERDOR code. A comparison is also made with a nuclear emulsion measured spectrum made with a different PoBe source. Using the KSU FERDOR results a source strength was calculated, $(2.120 \pm 0.029) \times 10^9$ neutrons per min; this compares well with a time corrected source strength calculated from the source vender's reported strength of 2.11×10^9 neutrons per min. (auth)

48956 (N-71-19136) DESIGN STUDY FOR A GAMMA-RAY SPECTROMETER FOR INTENSE GAMMA FIELDS. Final Report. Austin, W. E. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). 10 Dec 1970. Contract NAS8-25617. 123p. (NASA-CR-103046). NTIS.

A gamma ray spectrometer design is presented for use in intense gamma fields of 100 R/hr to 1,000,000 R/hr. A literature survey was conducted and the design approach selected uses Compton scatter attenuation to reduce the flux intensity to values suitable for spectral measurements. Other physical interactions were shown to have little effect on the Compton shifted energy spectrum. Sum-Compton spectral detectors were selected to give pulse height data directly convertable to the gamma spectrum through the detector energy response function and the

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Compton energy shift. Calculations of the fast neutron flux rate effect on the detectors indicated that flux intensities to 10 to the 9th power n/sq cm-sec could be tolerated. Three Compton targets were used to maintain the count rates between 500 and 10,000/sec over the four decades of incident gamma intensity. The electronic functions are specified and a spectrometer head conceptual design is proposed. The design weighs approximately 130 pounds, largely due to the necessary tungsten alloy shield. (auth) (STAR)

48957 VERSATILE dE/dx DETECTOR FOR HEAVY MASS NUCLEAR PARTICLES. Muga, M. L. (Univ. of Florida, Gainesville). Nucl. Instrum. Methods; 95: No. 2, 349-59(1971).

A development in the art of heavy-fragment (heavy-nucleus) particle detection and identification is reported. Recent improvements in the thin film detector have made it possible to achieve an output pulse responding to the energy loss, ΔE, experienced by the heavy fragment in traversing the scintillator film. Typically, for ^{252}Cf fission-fragment energy losses of about 10%, a clear separation between the light and heavy fragment ΔE signals is observed. In recording the ΔE spectrum, peak-to-valley ratios greater than 5:1 are obtained in the best cases. Exploratory experiments on light fragments clearly show the different energy losses experienced by ^{3}He and ^{4}He ions of comparable energies. The signal response (when thicker scintillator films are used) to total energy loss of alpha particles and fission fragments is reported. A preliminary view of the response of the new detector to accelerated ^{127}I ions is also shown. The possible use of these detectors as particle identifiers of heavy-mass nuclei is discussed, and an attendant wide range of experiments to which these ΔE detectors might profitably be applied is outlined. (auth)

48958 AVALANCHE-TYPE GaAs RADIATION DETECTORS. Kobayashi, T.; Takayanagi, S. (Tokyo Shibaura Electric Co., Ltd., Kawasaki, Japan). Nucl. Instrum. Methods; 95: No. 2, 365-7(1971).

Surface-barrier diodes made from high-purity GaAs material were operated as an avalanche-type detector for alpha particles. The maximum multiplication factors measured were 2 and 5 for 5.15-MeV alpha particles and a chopped light beam, respectively. The relatively small multiplication factors of these GaAs diodes were due to inhomogeneity of the GaAs materials used. (auth)

48959 MOESSBAUER VELOCITY CALIBRATION VIA INTERFEROMETRY. Cosgrove, J. G.; Collins, R. L. (Univ. of Texas, Austin). Nucl. Instrum. Methods; 95: No. 2, 269-74 (1971).

Velocity calibration in Moessbauer spectrometers operated in the constant acceleration mode is achieved by laser interferometry. The fringe rate measures absolute velocity. The preferred mode of operation multiplexes the Moessbauer spectrum, velocity, and timing signals onto a single record. A computer program for handling the data is described. (auth)

48960 STABILIZED SPECTROMETER WITH A Ge(Li) DETECTOR USING A NTA-512 ANALYZER. Murzin, A. V. (Inst. of Physics, Kiev). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 6, 1575-7(Nov-Dec 1970).

Translated from Prib. Tekh. Eksp.; No. 6, 28-31(Nov-Dec 1970).

A system for stabilizing a semiconductor spectrometer with a Ge(Li) detector using an NTA-512 analyzer (Hungary) is described. Stabilization is accomplished by means of the standard signals of two precision pulse-height generators. A stability of the position of the γ lines on the analyzer of $0.004-0.005\%$ deg^{-1} is achieved. (auth)

48961 GAMMA RAY MEASUREMENTS WITH PLASTIC SCINTILLATORS. Nardi, E. (Israel Atomic Energy Commission, Yavne. Weizmann Inst. of Science, Rehovot, Israel). Nucl. Instrum. Methods; 95: No. 2, 229-32(1971).

It is shown that the proportionality factor between the total gamma-ray energy absorbed by a plastic scintillator and the energy of the gamma ray incident on the scintillator is essentially independent of the incident gamma-ray energy. This property is verified both experimentally and on the basis of Monte Carlo calculations. Good agreement was also obtained between experimental spectra and results of Monte Carlo calculations; hence, the Compton edge of the gamma spectrum could be accurately identified. (auth)

48962 BREIT-WIGNERS VIEWED THROUGH GAUSSIANS. Wilkinson, D. H. (Univ. of Washington, Seattle). Nucl. Instrum. Methods; 95: No. 2, 259-64(1971).

The frequently-occurring situation is analyzed in which a signal of Breit-Wigner form, as, for example, a particle group from a state in the continuum of an excited nucleus, is detected by a measuring instrument whose resolution function may be represented by a Gaussian, such as a solid-state detector for this example, so that the observed signal is a convolution of the Breit-Wigner and the Gaussian. Tabular, graphical, and analytical answers are given to the questions: What is the form of the convoluted signal? By how much is the peak height lowered by the convolution? How is the Breit-Wigner width Γ to be extracted? What fraction of the area under the convoluted peak lies outside given limits? (auth)

48963 HIGH RESOLUTION SPECTROMETRY WITH NUCLEAR RADIATION DETECTORS. Kandiah, K. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods; 95: No. 2, 289-300(1971).

A high-resolution spectrometer system that contains optoelectronic charge restoration at the detector, direct-coupled signal amplification, active signal filters, and a versatile analog-to-digital converter is briefly described. The performance of this system with semiconductor gamma-ray and X-ray detectors, scintillation counters, and proportional counters over a very wide range of counting rates is described. Owing to the unique characteristics of this spectrometer, the performance with every detector tested is believed to be substantially better than that hitherto reported for any other spectrometer. It is shown that the overall performance is limited solely by noise at the input and by detector characteristics even with the best available detector. (auth)

48964 NUCLEAR GAMMA-RESONANCE SPECTROMETER OF CONSTANT SPEED. Bayukov, O. A.; Ikonnikov, V. P.; Petrov, M. I. (Inst. of Physics, Krasnoyarsk, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 6, 1572-4(Nov-Dec 1970).

Translated from Prib. Tekh. Eksp.; No. 6, 26-8(Nov-Dec 1970).

A Moessbauer spectrometer with constant speed drive is described, constructed from standard equipment. The automatic control and recording unit is assembled on the basis of two scalers with minor additions and alterations. (auth)

48965 FURTHER EXPERIENCE WITH Ge(γ) DETECTORS. Lawson, E. M. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Nucl. Instrum. Methods; 95: No. 2, 361-3(1971).

Two γ-ray-compensated detectors were made from 4×10^{11} donors cm^{-3} germanium. Capacitance was found to give a good indication of the sensitive volume. The maximum depletion depth was 8 mm. (auth)

48966 APPLICATION OF GERMANIUM p-i-n DETECTORS STABLE AT ROOM TEMPERATURE IN NONDISPERSION X-RAY ANALYSIS. Ryvkin, S. M.; Goganov, D. A.; Zhukovskii, A. N.; (and others) (Ioffe Inst. of Physics and Tech., Leningrad). Nucl. Instrum. Methods; 95: No. 1, 177-80(1971).

An x-ray spectrometer based on p-i-n detectors obtained by compensation of n-germanium by radiation defects is proposed. The detectors are stable at room temperature, with a thin entrance window and are made self-consistent which noticeably simplifies the x-ray spectrometer. The advantage of this spectrometer over spectrometers with Si(Li) detectors lies in the possibility of analyzing the heavy elements on K-series. In defining W and Hg in ores the threshold sensitivity $4 \times 10^{-3}\%$ was achieved. (auth)

48967 IMPROVEMENT OF THE RESOLUTION OF LARGE NaI-SCINTILLATION SPECTROMETERS FOR HIGH ENERGY PHOTONS. Ahrens, J.; Czock, H. H.; Mehlig, D.; Ziegler, B. (Max-Planck-Inst. for Chemistry, Mainz). Nucl. Instrum. Methods; 95: No. 1, 195-7(1971).

The response of a 9″ diam × 12″ NaI-spectrometer could be improved by inserting venetian blind type structures in between crystal windows and photomultiplier cathodes. (auth)

48968 COMPARISON OF SEVERAL METHODS PROPOSED FOR CORRECTION OF DEAD-TIME LOSSES IN THE GAMMA-RAY SPECTROMETRY OF VERY SHORT-LIVED NUCLIDES. Wiernik, M. (Soreq Nuclear Research Centre, Yavne, Israel). Nucl. Instrum. Methods; 95: No. 1, 13-18(1971).

Methods proposed by several authors for correction of dead-time losses in the gamma-ray spectrometry of very short-lived nuclides are reviewed and discussed. Experimental results obtained using four of the simplest ones are presented. The choice of the proper method for each dead-time range is discussed. (auth)

48969 SHORT NUCLEAR LIFETIME MEASUREMENTS VIA THE PULSE BEAM DELAYED-COINCIDENCE TECHNIQUE. Kim, H. J.; Milner, W. T. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods; 95: No. 3, 429-34(1971).

Lifetimes in the 10^{-10} sec range were determined by simultaneously observing the time as well as energy distributions of γ-rays detected by a large-volume coaxial Ge(Li) detector. This simultaneous observation was accomplished by the use of a two-

parameter analyzer operated in the 512 × 32 channel mode. The fiducial time for the time distribution was provided by the pulsed beam initiating (p,p'γ) and (p,nγ) reactions on enriched Cd targets. Observed time distributions of delayed γ-rays ranging from 300 to 700 keV were analyzed using three different methods: centroid shift, shape fitting and area analyses. Half-lives determined by these methods are mutually consistent. It is shown that the half-life corresponding to an observed shift as small as 1/140 of the prompt distribution width (fwhm) may be reliably determined from the data. (auth)

48970 NEUTRON CRYSTAL SPECTROMETER WITH EXTREMELY HIGH ENERGY RESOLUTION. **Birr, M.; Heidemann, A.; Alefeld, B. (Technische Hochschule, Munich). Nucl. Instrum. Methods; 95: No. 3, 435-9(1971).**

A new neutron spectrometer was developed at the reactor in Munich. It is based on the fact that scattering at a Bragg angle near to 90° (backscattering) produces a highly monochromatic neutron beam. The total resolution of the instrument is $(6.2 \pm 0.7) \times 10^{-7}$ eV. The energy of the neutrons striking the sample is varied by Doppler-shifting, and energy changes in the order of $10^{-6}-10^{-7}$ eV can be measured. (auth)

48971 VERTICALLY BENT PYROLYTIC GRAPHITE CRYSTALS APPLIED TO TRIPLE-AXIS NEUTRON SPECTROMETRY. **Nunes, A. C.; Shirane, G. (Brookhaven National Lab., Upton, N. Y.). Nucl. Instrum. Methods; 95: No. 3, 445-52 (1971).**

A discussion is given of vertically bent pyrolytic graphic crystals used as monochromator or analyzer in triple-axis neutron spectrometers. A simple model is presented for estimating the flux gain to be achieved by bending the monochromator or analyzer, and the effects this bending has on instrumental resolution are also considered. Experiments with three monochromators bent to 50, 35, and 21 inch radii over a wide range of neutron energy (5 to 40 MeV) gave a maximum flux gain factor of 3.5 as predicted by the model, with no measurable change in resolution. In addition, if vertical resolution is not crucial, a further intensity gain can be achieved by using a bent analyzer. (auth)

48972 Q-VALUE FOR PARTICLE SPECTROMETERS. **Wollnik, H. (Osaka Univ.). Nucl. Instrum. Methods; 95: No. 3, 453-60(1971).**

The performance of magnetic or electrostatic particle spectrometers is usually evaluated according to the maximum obtainable resolving power. This is not a good method, since, in principle the resolving power of any instrument will be approximately infinite in the limit of vanishing particle currents. Here the product of resolving power and used phase space volume will be used to characterize a Q-value for a particle spectrometer. This parameter is related in a simple manner to the geometry of a system even in the case of multifield spectrometers and thus may be a useful guide during the design stage of an instrument. It is relevant that this Q-value does not depend directly on several quantities usually considered to be important for high performance instruments such as the inhomogeneity of sector fields or the angle of deflection of a spectrometer. (auth)

48973 SYSTEM FOR AUTOMATIC CONTROL AND REGISTRATION FOR A MAGNETIC β SPECTROMETER. Dioniso, J. S.; Marion, A. (CNRS, Orsay, France). Nucl. Instrum. Methods; 95: No. 3, 461-74(1971). (In French)

The main characteristics and performances of a new automatic operational unit for a magnetic β spectrometer are described. The primary improvement of this unit, compared with previous devices used for the same purpose, is the possibility of varying automatically the magnetic field with high accuracy according to an arbitrary set of values registered on a paper tape. A detailed discussion of the possibilities and limitations of these devices shows the particular ability of this special type of automatic unit which has been extensively tested and used in many spectroscopic studies. (auth)

48974 TIME-TO-PULSE HEIGHT CONVERTER WITH COMPENSATION FOR Ge(Li) DETECTORS. **Van Zurk, R.; Mougin, A. (CEN, Grenoble, France). Nucl. Instrum. Methods; 95: No. 3, 475-86(1971). (In French).**

A time to pulse height converter, including an adjustable device which compensates the timing errors due to leading edge variations of PIN detectors stop pulses, is described. Its start and stop inputs are gated by a medium speed parallel channel. Some factors interfering with the resolution time of the circuit are analyzed. Experimental results in a 350 keV to 2.75 MeV range are reported. At 1.33 MeV the full width at half maximum of the prompt resolution curve obtained with a scintillation counter and an 18 cm^3 Ge(Li) detector is 2.2 ns. (auth)

48975 MULTIWIRE PROPORTIONAL CHAMBER FOR USE IN A MAGNETIC SPECTROGRAPH OF HIGH DISPERSION. **Becker, H.; Kalbitzer, S.; Rieck, D.; Wiedner, C. A. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Instrum. Methods; 95: No. 3, 525-32(1971).**

A multiwire proportional chamber with a sensitive volume of $20 \times 2 \times 1$ cm^3 has been developed for the adaption to the focal plane of a magnetic spectrograph. The position information of the incident ionizing particles is obtained by using the charge dividing properties of a resistive network. Tests with light particles in the energy range between 5 and 18 MeV have yielded position resolutions of better than 1.5 mm (fwhm). The integral nonlinearity of the position information was less than 0.5%. The position spectra show extremely low background. Particle identification up to mass 4 seems possible. (auth)

48976 DIMINUTIVE CORONA SPARK DETECTORS FOR FISSION FRAGMENTS. **Stubbins, W. F.; Craig, W. W.; Shapiro, A. (Univ. of Cincinnati). Nucl. Instrum. Methods; 95: No. 3, 533-9(1971).**

Corona spark detectors for charged particles, with special value for fission fragment detection, are simply constructed with a repeating array of wires which minimizes the material in the sensitive region of the detector. Multiple advantages arise from the form of the detector which allows the use of detectors in tandem, the simultaneous detection of target and calibration foils, and the application of directional properties of the wire grid for angular distribution studies. Performance characteristics in detecting fission events are presented. (auth)

48977 MONTE CARLO SIMULATION OF AN ORGANIC SCINTILLATOR RESPONSE OF GAMMA-RAY SPECTRA. **Martin, I. M. (Comissao Nacional de Atividades Espaciais, Sao Jose dos Campos, Brazil); Bui-van, A.; Vedrenne, G. Nucl. Instrum. Methods; 95: No. 3, 545-50(1971).**

Inside a scintillator, the gamma-ray spectrum is transformed into an electron distribution. Numerical methods are useful to compute the gamma-ray spectral index from the pulse height spectra measurements. The use of Monte Carlo methods for this purpose is studied. A Monte Carlo simulation may take into account many effects produced inside the scintillator e.g., interaction width, detector geometry and energy resolution. For this reason, it gives results more accurate than other numerical approximations. The crystal sensitivity is then determined by this calculation procedure, using two different incident photon spectra. An initial power law flux is found to produce a pulse-height response characterized by adjacent regions of different slope. (auth)

48978 CALCULATED FIGURE OF MERIT FOR PLANAR AND CO-AXIAL GERMANIUM DETECTORS. **Gibbons, P. E.; Owen, R. B. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods; 95: No. 3, 551-5(1971).**

Theoretical values of the figure of merit for germanium detectors have been calculated and comparisons between alternative planar and co-axial geometries are made. (auth)

48979 IMPROVEMENT OF TIME MODE MOESSBAUER SPECTROMETER BY EMPLOYING A CRYSTAL OSCILLATOR AND PRESET COUNTERS. **Miyajima, Hideki; Iida, Shuichi (Tokyo Univ.). Radioisotopes (Tokyo); 20: No. 7, 331-2(Jul 1971).**

A time mode Moessbauer spectrometer, in which all signals for driving the velocity transducer and the multichannel analyzer (MCA) are made from a stable crystal clock by employing digital circuits, instead of using wave generators or D-A converters, is described. (W.H.K.)

48980 DETECTOR SYSTEM FOR THE ANALYSIS OF SCATTERED ELECTRONS IN TOHOKU UNIVERSITY 300-MeV LINAC. **Kimura, M. (Tohoku Univ., Sendai); Torizuka, Y.; Shoda, K.; (and others). Nucl. Instrum. Methods; 95: No. 3, 403-11(1971).**

The magnetic spectrometer to analyze the elastically and inelastically scattered electrons in combination with the Tohoku University 300-MeV electron linear accelerator is described with emphasis on its electron detection ladder and the data acquisition system. Si(Li) semiconductor detectors combined with the conventional logic circuits were used for the coincidence counter telescopes and also for the other circuitry system. Three detector pieces were used per channel and a total of 33 such channels were employed. Data was collected during the beam pulse intervals of about 3.3 msec, after each pulse. The stability of the counting efficiency of the detector channel and the angular constancy of the effective solid angle of the spectrometer were examined. (auth)

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48981 VERSATILE ALL-Ge(Li) ANTI-COMPTON SPECTROMETER. Alberti, G.; Isabella, L.; Oriani, A.; Zambra, A. (LABEN, Milan). Nucl. Instrum. Methods; 95: No. 3, 413-19 (1971).

An all-Ge(Li) anti-Compton spectrometer utilizing a more simple and reliable signal processing has been designed. The system has been tested with a 3 cm^3 planar and a 23 cm^3 planar and a 23 cm^3 coaxial detector. This set-up provides for good gamma ray energy resolution: 3.05 keV fwhm at 1.33 MeV for the 23 cm^3 coaxial spectrometer. Using a monochromatic 1.27 MeV gamma ray source a peak height-to-max background height ratio of 32.5 for the planar detector and of 45 for the coaxial detector has been obtained. The only relevant background in the gamma ray spectra performed is due to multiple Compton interactions, while the single Compton distribution is completely suppressed. (auth)

48982 METHOD FOR THE STUDY OF 100 ns TO 10 μs ACTIVITIES EXCITED BY 14.7 MeV NEUTRONS. Adam, A.; Kiss, A.; Mayr, E. (Central Research Inst. for Physics, Budapest). Nucl. Instrum. Methods; 96: No. 1, 213-14(1971).

A method is described for the investigation of isomeric levels of 0.1−10 μs half-life excited by 14.7 MeV fast neutrons from the $^3H(d,n)^4He$ reaction. The alpha particles arising from the neutron-producing reaction determine the zero of time. By combining the recoiled alpha particle method with suitable pulsing of the deuteron beam, a sufficiently high effect-to-background ratio was achieved to make the measurement feasible. (auth)

48983 PRECISE COMPARISON AND MEASUREMENT OF GAMMA-RAY ENERGIES WITH A Ge(Li) DETECTOR. II. 400 TO 1300 keV. Helmer, R. G.; Greenwood, R. C.; Gehrke, R. J. (Idaho Nuclear Corp., Idaho Falls). Nucl. Instrum. Methods; 96: No. 1, 173-96(1971).

The energies of 60 γ rays from 24 nuclides in the region 400 to 1300 keV have been measured with Ge(Li) spectrometers. The purpose of this work is to provide an extensive set of energy standards in this region. Typical uncertainties in the γ-ray energies are 15 eV at 600 keV (or 25 ppm) and 24 eV at 1100 keV (or 22 ppm). Several γ-ray energy values were obtained by using precise cascade γ-ray energies to compute the crossover energies. Other energies were then obtained by measuring small (<30 keV) energy differences. These differences generally have uncertainties of <5 eV. In this manner, two independent γ-ray energy sets were developed up to 1.3 MeV; these sets are based on the γ-ray energies from (1) ^{198}Au and ^{182}Ta or ^{59}Fe, and (2) ^{192}Ir and ^{160}Tb. From comparison of the energy values in these two sets, it has been determined that above 0.8 MeV the sets are inconsistent by 17 ± 4 eV; however, this discrepancy is reasonable considering the magnitude of the uncertainties in the γ-ray energies. A detailed discussion of the contributions to the errors in the γ-ray energies shows that the major contribution comes from the uncertainty in the reference energies available. This indicates that improvements in the accuracies of a factor of two or more could be obtained with more accurate reference energies. (auth)

48984 AUTOMATIC SEPARATION OF TRUE FROM BACKGROUND AND RANDOM COINCIDENCES. Ramadan, B.; Naqvi, S. I. H. (Univ. of Saskatchewan, Regina). Nucl. Instrum. Methods; 96: No. 1, 145-7(1971).

In γ-ray spectroscopy, one often looks for a spectrum in coincidence with a small peak which happens to be riding on the shoulder of other more intense γ-rays. For this, one usually takes a spectrum in coincidence with a window bracketing the peak and then subtracts from it the spectra taken by displacing the window to either side of the peak. This subtraction technique results in a coincidence spectrum free of chance as well as any genuine but unwanted background coincidences. The method, however, is time consuming and is particularly unsuitable for short lived activities. A system is described which permits simultaneous recording of the spectra in coincidence with the central and side windows. Test coincidence results using this system are shown. (auth)

48985 FACILITY FOR THE STUDY OF PHOTOPROTON ANGULAR DISTRIBUTIONS AND CORRELATED PHOTONEUTRON–PHOTOPROTON PAIRS. Irish, J. D.; Buchnea, A.; McConnell, D. B. (Univ. of Toronto). Nucl. Instrum. Methods; 96: No. 1, 125-34(1971).

A facility for measuring the angular distributions of photoprotons from solid targets is described. The proton spectrometer consists of an evacuated target chamber with lithium-drifted silicon detectors at angles of 30, 60, 90, 120, and 150° to the direction of the photon beam. When the proton spectrometer is used in conjunction with a neutron detector (an 18 in. × 3 in. × 2 in. slab of plastic scintillator viewed by two photomultiplier tubes, one at each end), the facility becomes capable of detecting neutrons and protons in coincidence. These can be detected over a wide range of angles with a resolving time of ≲50 nsec. (auth)

48986 RAPID ANALYSIS OF GERMANIUM SPECTRA. Bowman, W. W. (Texas A and M Univ., College Station). Nucl. Instrum. Methods; 96: No. 1, 135-9(1971).

A computer program for the rapid analysis of gamma-ray spectra obtained from Ge(Li) detectors is presented. The code utilizes a simple summation of the spectrum above a straight line background between carefully chosen boundary channels for the calculation of peak area and a least-squares parabolic fit to those channels whose contents are greater than half maximum for the determination of peak location. Both of these methods are used in a manner which makes allowances for closely spaced peaks. The code is configured such that computer time, memory and input requirements are minimal. Various tests on the precision of the method are also presented. (auth)

48987 FABRICATION OF HIGH RESOLUTION LITHIUM-DRIFTED GERMANIUM DETECTOR. Despande, M. D.; Mitra, S. K. (Tata Inst. of Fundamental Research, Bombay). pp 260-5 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

48988 SOME DATA FOR A SIX GAP BETA RAY SPECTROMETER. Ambardekar, S. K. (Tata Inst. of Fundamental Research, Bombay); Bharathi, S. M.; Baba, C. V. K. pp 266-9 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

48989 COUNTER TELESCOPE FOR USE IN THE STUDY OF NEUTRON INDUCED REACTIONS. Betigeri, M. G. (Bhabha Atomic Research Centre, Trombay, India); Lamba, C. M.; Sood, D. K.; (and others). pp 270-4 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

48990 CONSTANTS OF CHARGED PARTICLE IDENTIFIER. Gupta, S. K. (Tata Inst. of Fundamental Research, Bombay). pp 275-8 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

High Energy Physics Instrumentation

Refer also to abstract 48936.

48991 (JINR–13-4527) CONFERENCE ON FILMLESS SPARK AND STREAMER CHAMBERS. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1969. 312p. (In English and Russian). (CONF-690433).

The program of this international conference contains papers on mechanisms for the development of discharges in spark chambers, apparatus for wire and streamer chambers, multiwire proportional chambers, and a plan for connecting spark chambers with an electronic computer. Filmless methods of obtaining information from spark chambers are discussed. The use of vidicon systems to record spark chamber events, and experiments with capacitor storage for read-out are described. Wire spark chambers constitute the subject of a number of papers, with such variations as magnetostrictive and sparkostrictive types, and wire chamber polarimeters with core read-out. (K.S.W.)

48992 (JINR–P13-5868) THE CALCULATION OF ACHROMATIC PRISMS IN CHERENKOV COUNTERS. Zrelov, V. P.; Sulekova, G.; Sulek, P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). Jun 1971. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

The methods of calculation of achromatic prisms used to compensate radiation dispersion in Cherenkov devices are considered. Such prisms give an opportunity to guide Vavilov−Cherenkov radiation of two different wave lengths in the same direction. The prism is considered which has both refraction faces in a general position relative to the direction of the particle motion. Also, the calculation of an achromatic prism, the input refractive face of which is perpendicular to the particle motion direction is considered. The ALGOL-60 algorithms are listed. (W.H.K.)

48993 (SJC-T-70-4) CAMP: COMPUTER AIDED MEASURING PROJECTOR FOR BUBBLE CHAMBER PHOTOGRAPHS.

Yamagata, Taketora (Tokyo Univ. (Japan). Inst. for Nuclear Study). Sep 1970. 14p. Dep. NTIS (U. S. Sales Only).

The author intended to diminish the processing time in bubble chamber film analysis with a CAMP. The CAMP system comprises a film stage, Moire fringe digitizers, a desk-top screen, Rough Digitizers, a monitor TV, Dove prism control, automatic measuring device, and a computer with peripheral units including a CRT display with a light pen. The film stage, driven by servomotors, is controlled manually or by the computer. Film images, magnified by ten times, are projected on the desk-top screen. The desk is provided with the Rough Digitizers (Bloch-type string digitizers), which are used by a human operator to indicate to the computer three points on a track to be measured. The computer calculates a circular path connecting these points, and drives the stage along the path (30mm/sec). As the stage is driven, the automatic measuring device (AMD) scans and measures track segments on the fly. The AMD comprises a Dove mirror, a rotating mirror, slits and calibrating devices. The film area is scanned 100 times/sec within 2 mm from the optical axis. Calibrating light beam and a grating are used to calibrate the deflection angle of the rotating mirror. The I/O typewriter output gives the coordinates of three points measured by the Rough Digitizers, coordinates of intermediate points on the path and the corresponding increment of the Dove prism angle, the AMD output and a map of the AMD output expressed with the path coordinate system. A CRT display system is under construction. (Japan)

48994 ON-LINE DATA ANALYSIS FOR A DIGITIZED MULTIPLATE RANGE SPARK CHAMBER. Giordano, R. (Istituto Superiore di Sanita, Rome). Nucl. Instrum. Methods; 95: No. 2, 371-2(1971).

A very simple method of identifying tracks by analyzing pulses from a digitized multiplate range spark chamber by means of a small on-line computer is described. The gap memory is supposed to be short enough to permit the detection of the triggering particle without taking into account the immediately foregoing tracks. The uncertainty associated with the identification of the most likely track achieved by this method is also evaluated to give information about the detection reliability of the whole system. (auth)

48995 MULTIPLE TRACK GENERATOR AND READOUT SYSTEM FOR WIRE SPARK CHAMBERS. Briggs, D. D. (Wabash Coll., Crawfordsville, Ind.). Nucl. Instrum. Methods; 95: No. 2, 377-9(1971).

A 2-MeV/c electron is bent through a wire spark chamber several times by permanent magnets. Chamber efficiency is determined by counting magnetostrictive readout pulses with an integrated circuit device. (auth)

48996 STUDY OF THE EFFICIENCY CHARACTERISTICS OF FLASH TUBES. Hampson, H. F.; Rastin, B. C. (Univ. of Nottingham, Eng.). Nucl. Instrum. Methods; 95: No. 2, 337-44 (1971).

Neon flash tubes provide a useful means of delineating the trajectory of charged particles. This work represents a detailed investigation of the dependence of the efficiency of these detectors upon the parameters that control the mode of operation. Data are presented on the effects of varying the characteristics of the applied pulse as well as filling gas pressure, and these are explained from a theoretical standpoint. The effects of impurities in the neon upon this efficiency were measured; and the probability of a thermal electron's becoming attached to an oxygen molecule evaluated. Finally, the results of a limited study performed on tubes constructed of pyrex glass instead of the universally adopted soda glass are also given. (auth)

48997 SCINTILLATION COUNTERS EMPLOYING THE MINIATURE FEU-60 PHOTOMULTIPLIER. Derevshchikov, A. A.; Meshchanin, A. P.; Nurushev, S. B.; Siksin, V. V.; Smirnov, E. V. Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 6, 1587-9(Nov-Dec 1970).

Translated from Prib. Tekh. Eksp.; No. 6, 39-40(Nov-Dec 1970).

A scintillation counter based on the FÉU-60 photomultiplier is described for count rates up to 30 MHz. The possible design of miniature hodoscopic systems is discussed for experiments in high-energy physics. (auth)

48998 PULSE SHAPER FOR THE VIDEO CHANNEL OF A TELEVISION MEASUREMENT SYSTEM. Petrakov, A. V.; Klevalin, V. A.; Lebedev, B. A. Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 6, 1654-6(Nov-Dec 1970).

Translated from Prib. Tekh. Eksp.; No. 6, 97-9(Nov-Dec 1970).

Two networks for shapers of reference pulses whose discrimination threshold varies as a function of the video-signal level are advanced. The use of a shaper in the video channel of a television automaton for the acquisition of information from spark chambers allows the relative mean square error of measuring the coordinates of the reference marks to be reduced to $4 \cdot 10^{-4}$, and that of measuring the tracks of nuclear particles detected by the spark chamber to $\leq 10^{-3}$. (auth)

48999 COMPENSATING FOR THE EFFECT OF THE AMPLITUDE SPREAD OF COUNTER PULSES AT THE OPERATING MOMENT OF HIGH-SPEED SHAPERS. Lapshin, V. G.; Rykalin, V. I.; Tsisek, Z. Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 6, 1659-63(Nov-Dec 1970).

Translated from Prib. Tekh. Eksp.; No. 6, 101-5(Nov-Dec 1970).

The operating principle of a diode device, with a storage charge for compensating for the dependence of the start of operation of discriminators on the value of input pulse amplitudes, is described, and the principal circuit of a compensated shaper is shown. Compensation accuracy for a dynamic range of input amplitudes, D = 40, was $\Delta t = \pm 0.15$ nsec. The frequency range $f_{max} \simeq 60$ MHz. (auth)

49000 INVESTIGATION OF SPARK CHAMBER CHARACTERISTICS IN A MAGNETIC FIELD. Aref'ev, A. V.; Bayukov, Yu. D.; Efremenko, V. I.; (and others) (Inst. of Theoretical and Experimental Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 6, 1581-3(Nov-Dec 1970).

Translated from Prib. Tekh. Eksp.; No. 6, 34-6(Nov-Dec 1970).

The characteristics of an 8-mm spark gap are investigated by using photographs of particle tracks in a $150 \times 60 \times 40$-cm multilayer spark chamber, filled with a Ne + He mixture and placed in a magnetic field. The particle recording efficiency dependence on the time lag t_l of the high-voltage pulse is determined for different clearing fields V_{cl} and magnetic fields B. The spark shift in crossed electric and magnetic fields ($E \times B$ effect) is measured in dependence on t_l, V_{cl}, and B. The efficiency in recording several particles passing simultaneously and at different times is determined. The time of passage of the old particle is determined with respect to the magnitude of the $E \times B$ effect. (auth)

49001 EXPERIENCE WITH A STATIC MAGNETOSTRICTIVE READOUT SYSTEM FOR WIRE CHAMBERS. Longo, M. J. (Univ. of Michigan, Ann Arbor); Clark, J.; Edict, G.; (and others). Nucl. Instrum. Methods; 95: No. 1, 53-60(1971).

Bespalova et al. have described a scheme for wire chamber readout which makes use of the permanent magnetization of the magnetostrictive line for temporary storage of coordinate information. The advantage of this scheme is that it can significantly reduce the cost of the electronics needed to read out a system with many chambers. This technique was adopted to read out spark coordinates in an array of spark chambers to detect γ showers. This array was used successfully in an experiment in which $\approx 10^7$ events were recorded. Experience with this type of readout and its advantages and disadvantages relative to the more common "prompt" readout system are discussed. (auth)

49002 DETECTOR FOR DETERMINING THE DIRECTION AND ENERGY OF FAST NEUTRONS IN COSMIC RADIATION. Biswas, S.; Durgaprasad, N.; Kajarekar, P. J. (Tata Inst. of Fundamental Research, Bombay). Nucl. Instrum. Methods; 95: No. 1, 69-76(1971).

A method based on the reaction $^{10}B + n \rightarrow {}^4He + {}^4He + {}^3H + 0.3$ MeV for determining both the direction and the energy of fast neutrons of cosmic rays in the energy interval about 20 to 100 MeV is described. A test experiment was made using a small nuclear emulsion stack loaded with 95% enriched ^{10}B-isotope and flown in a balloon flight from Hyderabad, India in March 1968. A kinematical method is described for rapid selection of ^{10}B events and the background effect is estimated. The momenta, energies and arrival directions of a sample of fast neutrons are determined. (auth)

49003 LARGE-AREA PULSE IONIZATION CHAMBER FOR MEASUREMENT OF EXTREMELY HEAVY COSMIC RAYS. Epstein, J. W. (Washington Univ., St. Louis); Fernandez, J. I.; Israel, M. H.; (and others). Nucl. Instrum. Methods; 95: No. 1, 77-85(1971).

Parallel-plate ionization chambers with nearly 1 m^2 active area were constructed and successfully operated in a series of high-altitude balloon flights. The chambers are used for identification of relativistic cosmic-ray nuclei with charge greater than or equal to 20. For relativistic iron nuclei (charge 26) the charge resolution (fwhm) achieved is 5.5% (i.e., less than 1.5 charge units). (auth)

49004 MONTE CARLO CALCULATION OF ENERGY SPECTRA ON A γ-COUNTER IN DETECTION OF η^0 AND π^0 MESONS. Kobayakawa, H. (Nagoya Univ., Japan); Obayashi, H.; Ukai, K.; Yoshida, K. Nucl. Instrum. Methods; 95: No. 1, 103-8(1971).

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Energy spectra of gamma-rays from η^0 and π^0 mesons produced in the γ + p reactions are computed by the Monte Carlo method. The detector system consists of a Cherenkov counter with large aperture and some electronic circuits. In the course of the calculation the measured characteristics of the system, such as the energy resolution of the counter, the sensitivity of the acceptance area and the signal modification in the circuit system, are taken into account. The kinematical efficiency for detecting the gamma-rays from η^0 and π^0 mesons is given in terms of a weight function proportional to the Lorentz invariant phase volume. This saves much of the computing time of the Monte Carlo treatment. The comparison with the experimental energy spectra shows the usefulness of the present computational scheme. (auth)

49005 TECHNIQUE OF MASS DETERMINATION OF SLOW COSMIC RAY PARTICLES USING A LARGE APERTURE RANGE TELESCOPE. Ashton, F.; Edwards, H. J.; Kelly, G. N. (Univ. of Durham, Eng.). Nucl. Instrum. Methods; 95: No. 1, 109-18 (1971).

A description is given of the design and performance of a large aperture range telescope which is capable not only of mass discrimination but also of mass measurement over a range of several GeV/c^2. Discussion is also given of the possibility of charge identification with such a telescope using a combination of Cherenkov counters and scintillation counters as the velocity detectors. (auth)

49006 BALLOON BORNE INSTRUMENT FOR THE STUDY OF COSMIC X-RAYS. Agrawal, P. C.; Iyengar, V. S.; Kalgaonkar, M. A.; (and others) (Tata Inst. of Fundamental Research, Bombay). Nucl. Instrum. Methods; 95: No. 1, 29-37(1971).

Design features of a balloon borne instrument for the study of cosmic x-rays are described. Advantages of equatorial location for investigations in x-ray astronomy are discussed. Details of the x-ray telescope and associated instrumentation are described. A summary of the performance of the instrument and results obtained in three balloon flights are presented. (auth)

49007 HIGH RESOLUTION MULTIWIRE PROPORTIONAL CHAMBERS AND A READOUT SYSTEM FOR SECONDARY BEAM LINE INSTRUMENTATION. Atac, M.; Martin, R. G. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 435-7(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Multiwire proportional chambers with 1-mm and 0.5-mm wire spacing have been built at NAL and tested at Argonne National Laboratory using a spatially separated π^+ beam of 2 GeV/c. These chambers, with an active area of 10 cm^2, have detection efficiencies of above 98% and a spatial resolution of ±0.5 mm and ±0.25 mm with the 1-mm and 0.5-mm wire spacing respectively. A gas-multiplication factor of 10^5 was reached using 10-micron diameter tungsten wires. Time resolutions of 16 nsec (fwhm) were obtained from the 0.5-mm wire-spacing chamber. Count-rate capabilities larger than 10^6 per second enable the observation of secondary-beam profiles quickly with negligible multiple Coulomb scattering at NAL energies. Implications for the instrumentation of NAL beam lines are discussed. (auth)

49008 DIGITALLY CONTROLLED FAST FILM TRANSPORT. Zivkovic, D. (Univ. of Birmingham, Eng.). Nucl. Instrum. Methods; 96: No. 1, 9-11(1971).

The problem of detecting the length of film loops inside vacuum boxes can be solved by mounting simple digital encoders on rollers that guide the film into the boxes. (auth)

49009 ON-LINE STORAGE DISPLAY SYSTEM. Zivkovic, D. (Univ. of Birmingham, Eng.). Nucl. Instrum. Methods; 96: No. 1, 13-19(1971).

A storage display monitor is used for on-line display of bubble chamber photographs measured by an automatic measuring system. A problem arises when the line scanning speed of the measuring device exceeds the writing speed of the storage display. This has been solved by stopping the deflection of the display beam for the minimum writing period whenever a dot is to be displayed. The display system provides enlargement of any area on the screen and it indicates the enlarged display area with frame superimposed upon the original picture. The frame is not stored so that it can be moved around the picture. (auth)

49010 AUTOMATIC SCANNING DEVICE FOR NUCLEAR TRACK PLATES. Flynn, E. R.; Gardiner, T.; Seamons, M. J.; Orbesen, S. D. (Los Alamos Scientific Lab., N. Mex.). Nucl. Instrum. Methods; 96: No. 1, 107-23(1971).

An automatic scanning device for nuclear track plates is described. This machine, built especially for photographic emulsions exposed in magnetic spectrographs, utilizes a spiral scanning disc and an on-line computer. This arrangement makes possible the automatic scanning of a 1-cm wide band, 25 cm long, in 14 min or about 100 times faster than human scanning. A detailed description of the system is given as well as operating conditions and limitations on plate quality and track density. (auth)

49011 EXPERIMENTAL METHOD OF RADIATIVE CORRECTION IN COINCIDENCE MEASUREMENT OF INELASTIC ELECTRON SCATTERING. Hamatsu, R. (Hiroshima Univ.); Kajiura, N.; Kaneko, S.; Ohsugi, T.; Kobayashi, Y. Nucl. Instrum. Methods; 96: No. 1, 101-6(1971).

An experimental method of calibration for the radiative process in double-arm coincidence measurement of inelastic e-p scattering is discussed. The method involves representing the radiative effect in the inelastic scattering in terms of an integral of the radiation probability and comparing it with the corresponding integral measured in the single-arm elastic scattering experiments. This allows us to cancel out an ambiguity caused by the radiative correction and to represent the inelastic cross section to be measured in terms of the well-established elastic cross section. The correction for averaging the cross sections is also discussed. (auth)

49012 MANUAL MEASUREMENT OF PHOTOGRAPHS BY SCANNING WITH A LASER BEAM. Boulanger, J. P.; Lafontaine, A.; Pottier, J.; Tanguy, J. P. (CEN de Saclay, Gif-sur-Yvette, France). Nucl. Instrum. Methods; 96: No. 1, 85-8 (1971). (In French).

A device designed for the manual measurement of photographic tracks is described. A time encoding technique is used to obtain the angular positions of three rotating laser beams as they strike a reflecting pointer. The precision obtained is between 20 μm and 150 μm according to the position of the pointer, on the table (1 m × 0.6 m) on which photographs are projected. Since no precision mechanics are required such a device is fairly inexpensive, and it offers the combined advantages of wire devices and mobile film systems. (auth)

49013 INVESTIGATION INTO THE FLASH TUBE DISCHARGE MECHANISM. Hampson, H. F.; Rastin, B. C. (Univ. of Nottingham, Eng.). Nucl. Instrum. Methods; 96: No. 1, 197-203(1971).

Though flash tubes have been used successfully as a means of locating the trajectory of charged particles the processes involved in the discharge mechanism have remained indefinite. An investigation is described using cosmic ray muons as the triggering particles from which it is possible to conclude that in tubes filled with neon to a pressure of one atmosphere the number of electrons produced by the passage of the muon is sufficient to allow the transition from an electron avalanche to a streamer to take place. In the higher pressure tubes, however this is not the case, the avalanche-streamer transition occurring some time after the discharge of the tube when the free electron density has reached a sufficient level to enable streamers to develop. Further the average spacing between the streamers occurring within the flash tubes has been found to be in agreement with the results of other workers. It has also been shown that the neon metastable states have little effect on the number of free electrons present in the tube. (auth)

49014 SOFTWARE SYSTEM FOR THE AUTOMATIC RECOGNITION OF BUBBLE CHAMBER EVENTS. Brokate, K. (IBM, Heidelberg); Erbe, R.; Keppel, E.; (and others). Nucl. Instrum. Methods; 96: No. 1, 157-71(1971).

A FORTRAN IV program system has been completed, which allows the automatic recognition, space reconstruction and topological interpretation of arbitrary elementary particle interactions. Normal input to the program is in the form of a sequence of uncorrelated line elements, into which track chamber photographs are decomposed e.g., by a PEPR film measuring device. The output can be obtained in the form of standard input to the kinematics program GRIND or to the geometry program THRESH—in both cases either containing all tracks on the film or just selected event topologies. The program makes complete ionization analysis of all tracks. In its normal mode the program does not need any human scanning or premeasurement of the film. An optional minimum guidance mode is incorporated, which is useful for experiments where very short tracks are numerous. The program can run in 85,000 words of core storage; it takes 9–11 sec per frame of CPU time on an IBM/360-65. 75% of all K^- interactions in hydrogen at 670 MeV/c were found and completely reconstructed in space using the automatic mode; for the two prong event type an efficiency of 80% was obtained. Some examples of the program's operation are presented. (auth)

49015 HIGH RESOLUTION LOW TEMPERATURE WIRE SPARK CHAMBERS. Atac, M. (National Accelerator Lab., Batavia, Ill.). Nucl. Instrum. Methods; 95: 521-3(1971).

Narrow gap spark chambers operating at low temperatures have been developed. Results show that spatial resolutions of 65 to 75 μm can be obtained. (auth)

49016 LARGE LIGHTWEIGHT MIRROR FOR USE IN CHERENKOV COUNTERS. Coyle, D. E.; Field, R. C.; Gunn, J. T.; Tanabe, J. T. (Univ. of California, Berkeley). Nucl. Instrum. Methods; 95: No. 3, 557-61(1971).

The construction is described of Cherenkov counter mirrors of dimensions 120 cm × 120 cm, presenting on average 0.7 g/cm^2 to penetrating particles, yet with optical qualities adequate to allow a simple light collection system. (auth)

Radiation Dosimeters

Refer also to abstracts 48616, 49170, 49185, 49188, 49191, 49250, and 49319.

49017 (AD-718370) DEVELOPMENT OF AN INTERMEDIATE- AND HIGH-ATOMIC-NUMBER DOSIMETER. Final Report, December 5, 1969–December 5, 1970. Tochilin, Eugene; LaRiviere, Philip D. (Environmental Science Associates, Burlingame, Calif.). Dec 1970. Contract DASA01-70-C-0027. 85p. (ESA-TR-70-3; DASA-2576). NTIS.

The report covers an investigation of potential high-atomic-number thermoluminescent (TL) and thermally-stimulated exoelectron-emission (T-SEE) dosimeters with upper-range capabilities extending to 10 to the power of 6 R. The TL characteristics of five phosphors, BaF_2, MgF_2, MgO, SrF_2 and Y_2O_3, were investigated over an ionizing-radiation-exposure range of from 10R to 10 to the power of 6 R. Similar measurements were made also with ThO_2 between 10 to the power of 4 and 1.6 × 10 to the power of 6 R. All phosphors were judged to be usable dosimeters within the noted range limitations. (auth) (USGRDR)

49018 (ANL-7760(Pt.3), pp 26-9) THERMOLUMINESCENT DOSIMETRY OF AQUATIC LIFE IN-TRANSITU THROUGH A REACTOR COOLING CONDENSER. Oltman, B. G.; Romberg, Gerald P.; Prepejchal, William; Nelson, Donald M. (Argonne National Lab., Ill.).

In Radiological Physics Division annual report.

The use of encapsulated thermoluminescent dosimeters for measuring the radiation dose that aquatic organisms might be exposed to in passing through a nuclear power plant condenser is described. (W.H.K.)

49019 (COO-1105-167) NEW APPROACHES FOR FAST NEUTRON SOLID STATE DOSIMETRY. Moran, P. R.; Cameron, J. R. (Wisconsin Univ., Madison). [1970]. 12p. (CONF-701112-4). Dep. NTIS.

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970).

New lines of research for solid state fast neutron dosimeters are outlined. The basic experimental problems related to the detection of radiation damage centers are reviewed, an upper bound on radiation induced defect center concentrations in solids is estimated. The most successful schemes are likely to be, as with sensitive gamma dosimeters, those based upon optical or solid state chemical interaction phenomena. Intrinsic instabilities in probe sources and fluctuations in sample properties imply that only non-subtractive detection methods promise to achieve the sensitivities required for personnel dosimetry. Some examples of non-subtractive optical detection techniques which have been successfully exploited in other high sensitivity applications are discussed, and some classes of hydrogen-rich solids which would appear to have the solid state physics properties desirable for dosimetric applications are suggested. Among the optical methods worthy of investigation are: photoexcitation fluorescence, photoconductivity, excitonic phosphorescence, Rayleigh scattering and Raman scattering. Some of the materials under investigation include the cyclic hydrocarbon solids, simple grouped organic solids, and both pure and activated ammonium salts. The results of preliminary experiments along these lines are reported. (auth)

49020 (RT/PROT-(71)16) OBSERVATIONS ON THE PERIODIC RADIOMETRIC CALIBRATION OF PORTABLE PROTECTION DOSIMETERS. Casnati, E.; Scarpa, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 22 Apr 1971. 30p. (In Italian). Dep. NTIS (U. S. Sales Only).

The meaning of cyclic calibrations of a dosimeter is discussed with special regard to instruments used in the field of radiation protection. After a detailed analysis of the main parameters affecting the response of a dosimeter, some typical calibration protocols are proposed. In order to assess the actual behavior of routine instruments used in a radiation protection service, a preliminary survey was carried out both on portable exposure-rate meters and on personnel ion chamber dosimeters. Within each of the classes a distinction was made between new and used detectors. The study showed that, on the whole, the reproducibility of personnel dosimeters was distinctly better than that of exposure-rate meters. Furthermore, irrespective of the kind of instruments, no significant correlation was found between age and reproducibility of the detector, with the obvious exception of definitely worn out instruments. The results of this investigation strongly support the importance of regular calibrations to be carried out on the dosimetric devices, according to detailed protocols. (auth)

49021 (UCRL-50007-71-1) HAZARDS CONTROL PROGRESS REPORT NO. 39, JANUARY-APRIL 1971. (California Univ., Livermore. Lawrence Radiation Lab.). Contract W-7405-eng-48. 14p. Dep. NTIS.

Continuing work on radiation protection, instrumentation development, fire safety, and industrial hygiene is described. Technical information is given concerning the areas of radiation protection (energy dependence of LRL personnel dosimeters and calibration of the ^{60}Co irradiation facility), environmental protection (the LRL weather site), and education and training (computer code for field team training records). Abstracts for recent publications are included. (R.W.R.)

49022 HIGHLY SENSITIVE THERMOELECTRICAL X-RADIATION MICROCALORIMETER. Kozyrev, B. P.; Sheveleva, T. Yu. (Leningrad Electrotechnical Inst.). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 6, 1772-4(Nov-Dec 1970).

Translated from Prib. Tekh. Eksp.; No. 6, 193-5(Nov-Dec 1970).

Two microcalorimeter designs for measuring x-radiation intensities of 10 to 200 keV are described. In the quanta energy operating range, the devices do not have "motion with rigidity." The value of the threshold power equals $2 \cdot 10^{-8}$ W ($5 \cdot 10^{-9}$ W/cm^2). The microcalorimeters have a linear scale, and measure x-radiation intensity in the $5 \cdot 10^{-7}$ to $5 \cdot 10^{-2}$ W/cm^2 range with an error of 1.5%. (auth)

49023 PRODUCTION OF LOW X-RAY EXPOSURE RATES. Henry, W. H. (National Research Council of Canada, Ottawa). Health Phys.; 21: No. 1, 111-13(Jul 1971).

A simple method is described for producing exposure rates of known magnitude for calibrating instruments down to protection levels of x radiation. The exposure rate at a distance of 1 m was proportional to the tube anode current to within 1% over a range of 4 decades for a Mueller MO 100-kV tube operating at 30 kV and over a smaller range for a 250-kV "constant potential" industrial radiography machine (Westinghouse) operating at 110 kV. If a constant generating voltage were maintained as the tube current was altered, proportionality might hold for other types of tubes. (UK)

49024 PREPARATION AND STUDY OF $CaSO_4$:Mn SUITABLE FOR DOSIMETRY. Kasa, I.; Porubszky, I.; Kiss, L. (Technical Univ., Budapest. National F. Joliot Curie Radiobiological and Radiohygiene Research Inst., Budapest). Acta Chim. Acad. Sci. Hung.; 68: No. 1-2, 11-19(1971).

A study was made of the preparative conditions of manganese-activated calcium sulfate phosphors suitable for dosimetry and their effect on the thermoluminescent properties. Under the experimental preparative conditions studied, the optimum method of introduction of the activator was determined. The most favorable properties were possessed by those phosphors in which the introduction of the activator took place in acidic medium before the separation of the calcium sulfate. From a study of the effect of the heating atmosphere on the sensitivity, it was found that (since manganese ions oxidized to a valency state higher than two are responsible for the lower sensitivities of the samples heated in air), inasmuch as these oxidized manganese ions were subsequently reduced to divalent manganese and removed, the light intensity and sensitivity of the samples prepared in an atmosphere of air closely approached or reached the corresponding data of the samples prepared in the reducing atmosphere. In every sample the γ-ray dose is measured linearly in the examined region (10^{-2} to 10^2 R). (auth)

Radiometric Instruments

Refer also to abstracts 48532 and 49049.

49025 (INP-743) MEASUREMENT OF THE AIR-EXCHANGE RATE IN COOLING CHAMBERS BY MEANS OF BETA IONIZING DETECTORS. Korbel, K.; Lasa, J.; Korus, A. (Institute of Nuclear Physics, Krakow (Poland)). 1971. 23p. (In Polish). Dep. NTIS (U. S. Sales Only).

A description of the new method of air-exchange-rate measurement in cooling chambers by means of nonradioactive tracers is

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presented. The tracing gases CO_2, N_2O and Freon-12 are used. The determination of the tracer concentration in chamber-air is accomplished by means of the specially developed beta-ionizing detector provided with a ^{63}Na radiation source. The described method may be applied as well in the stationary conditions as during the movement of the examined cooling vane. Total error of the air-exchange-rate determination for CO_2 and N_2O is about 25% whereas for Freon-12 it equals 4%. (auth)

49026 (INR–1272) BETA-BACKSCATTERING INVESTIGATIONS FOR COATING THICKNESS MEASUREMENTS. Szepke, Ryszard (Institute of Nuclear Research, Warsaw (Poland)). 1971. 104p. (In Polish). Dep. NTIS (U. S. Sales Only).

The results of all investigations concerning thickness measurements by the beta-backscatter method are described. This research was concerned, among other things, with the atomic number of the irradiated material, angular distribution of the back-scattered beta particles, geometry, energy spectrum, intensity of detector irradiation, thickness of single or multilayer coating, reflection factor, radiometric errors, state of surface, hardness of material, etc. An equation for the beta-backscatter curve is derived by assuming that the curve consists of two variable components dependent upon base and coating layers. It is proved that the reflection factor is also dependent on material and thickness of coating. The curve in question, which was verified by experimental data, may be reproduced by computer for every coating/base combination, in accordance with the included program in Algol IV. Another computer program for the calculation of the equation of the backscatter curve vs the atomic number of the coating material is also developed, as well as for calculation of radiometric errors. The work also contains analysis and conclusions of 108 references on beta-backscattering. The results presented elaborate the method and the gage for coating-thickness measurements. There is a possibility for using the data presented for other applications, too. (auth)

49027 (INS-TL–110) ALPHA THICKNESS GAUGE. Nonaka, Itaru; Sugai, Isao (Tokyo Univ. (Japan). Inst. for Nuclear Study). 1 Dec 1970. 37p. (In Japanese). Dep. NTIS (U. S. Sales Only).

An alpha radiometric thickness gage for thin films is described. An americium-241 alpha source and semiconductor detector are used. Experimental results are presented and discussed for copper, gold, and aluminum films. (W.H.K.)

49028 (JAERI–13741) MEASUREMENT OF GROUND DENSITY USING THE DEPTH TYPE GAMMA SCATTERING DENSITY METER. Tominaga, Hiroshi; Wada, Nobuo; (and others) (Japan Atomic Energy Research Inst., Tokai). Oct 1969. 36p. NTIS (U. S. Sales Only).

The density of ground was measured by using a depth type gamma scattering density meter in reply to the request of investigation of landslide strata. The response of a depth type gamma scattering density meter is affected by many different factors. Therefore, in gamma-gamma logging, any good result can not be obtained unless the counts of scattered gamma-rays are corrected according to the actual field condition. The standard calibration curves which can be modified for any size of diameter of bore hole were prepared using the standard samples evenly crammed in drums (87 cmϕ × 57 cm) in advance of field experiments. (water: $\rho = 1$, sand: $\rho = 1.36$, sand filled water: $\rho = 1.84$, concrete: $\rho = 2.28$). In practice, the calibration curves were further corrected regarding the attenuation of gamma-rays due to the inside water of bore hole. The values of density determined by the method agreed well with those of sampled cores. (auth)

49029 RADIOISOTOPIC GAGES IN POLLUTION CONTROL. Gerrard, Martha. Isotop. Radiat. Technol.; 8: No. 4, 395-7 (Summer 1971).

An eggshell-strength gage, a suspended-sediment gage, and other radiometric gages for pollution control are briefly discussed. (W.H.K.)

49030 PROCESS CONTROL BY MEANS OF RADIOMETRIC MEASURING AND CONTROL DEVICES. Kosmowski, A. Konstr. Elem. Method.; 8: No. 1, 61-3(1971). (In German).

After a brief treatment of the setup of radiometric measuring and control devices, applications according to the transmission method are given including: (1) dry-weight measurement in the wet region of paper webs; (2) coating control according to the difference measuring method; and (3) control of coated (e.g. PVC) fabrics. (INIS)

49031 USE OF THE $^7Li(p,n)^7Be$ REACTION WITH A DYNAMITRON ACCELERATOR FOR THICKNESS AND DEPTH MEASUREMENTS. Walker, J.; Weaver, D. R. (Univ. of Ottawa). Nucl. Instrum. Methods; 96: No. 1, 93-9(1971).

To investigate its possible use in thickness and depth measurements, the yield of the $^7Li(p,n)^7Be$ reaction has been measured near threshold with and without nickel foils in front of the target. Protons of energies appropriate to each foil thickness were obtained from the Ottawa Dynamitron accelerator and the neutrons produced were detected by an orthodox long counter. The apparent shifts in the threshold energy, linked with range–energy information, provided foil thicknesses for comparison with those from weighings; an attempt was also made to assess non-uniformity of foil thicknesses from the shapes of the yield curves. (auth)

49032 THIN FILM THICKNESS DETERMINATION BY ALPHA PARTICLE BACKSCATTERING. Childs, W. A.; Lenz, G. H. (Univ. of Virginia, Charlottesville). Nucl. Instrum. Methods; 95: No. 3, 441-3(1971).

A method of determining the thickness of thin films deposited on thick, high mass backing materials by measuring the energy loss of alpha particles backscattered from the backing is described. Film thicknesses from 20 to 500 $\mu g/cm^2$ can quickly and easily be determined to an accuracy of 8 percent. (auth)

49033 METHOD AND APPARATUS FOR DETERMINING THE MASS OF MICROFINE PARTICLES. Murayama, Yoshimasa (to Hitachi, Ltd.). U. S. Patent 3,567,937. 2 Mar 1971. Priority date 27 Jun 1966, Japan.

A method and an apparatus for determining the mass of a particle by making use of resonance absorption of γ-rays are described. An emission and absorption of γ-rays are caused between nuclei of the same kind contained in both a microfine particle and a solid body which are in relative motion; the recoil energy of the particle which recoils inversely proportionally to its mass at the time of the emission and absorption of γ-rays is compensated for by the said relative motion to cause resonance absorption. The mass of the particle is determined from the relative velocity. (auth)

Miscellaneous Instruments and Components

Refer also to abstracts 48503, 48618, 48657, 48701, 48935, 49008, 49009, 49012, 50572, 50576, 50577, 51054, and 51111.

49034 (AERE-R–6723) HARWELL 7000 SERIES CAMAC CONTROLLERS. Richards, J. M. (Atomic Energy Research Establishment, Harwell (England)). Apr 1971. 48p. Dep. NTIS (U. S. Sales Only). UK 35p.

The CAMAC specification defines the essential features of data handling modules for use in the CAMAC system, but it leaves great freedom in the design of units to control such modules. A modular system of control units which was developed at A.E.R.E. Harwell is described. It is a revised and enlarged version of an earlier report on the same subject. (UK)

49035 (AERE-R–6817) PARALLEL PROCESSING COUPLER FOR CAMAC-COMPUTER SYSTEMS. Whitehead, N. P. (Atomic Energy Research Establishment, Harwell (England)). Jun 1971. 8p. Dep. NTIS (U. S. Sales Only). UK 9p.

The concept of a CAMAC "coupler" (comprising of device handler software and hardware controller) is reviewed together with parallel processing of CAMAC I/O Program Segments; and an I/O processor designed as the hardware analogue of the device handler software is described. (UK)

49036 (FRNC-TH–47) THE UTILIZATION OF A SMALL ON-LINE COMPUTER IN NUCLEAR PHYSICS. APPLICATION TO THE $^6Li(n,p)$ REACTION AT 14 MeV. Tournier, Marcel (Grenoble Univ. (France). Faculte des Sciences). 1970. 64p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The $^6Li(n,p)$ experiment was affected at 14 MeV under satisfactory conditions using on-line data acquisition and handling equipment. All the channels of the computer (CAB 500), in spite of being very slow (10 characters per second), were well adapted to the experiment performed (0.2 events per second). The data acquisition and handling program was written in machine language to take advantage of all the available space, which in addition to this program and the ancillary programs necessary for the peripheral operation contains two 50 line 128 column matrices. The entire 16 K memory of the computer was utilized, the matrices occupying 6.25 K, the programs 1.25 K, and the remainder being reserved for the basic microprograms. (France)

49037 (INS–458) PROGRESS REPORT [NO. 15], JANUARY–JUNE 1970. Contribution No. 466. (Institute of Nuclear Sciences, Lower Hutt (New Zealand)). 80p. Dep. NTIS (U. S. Sales Only).

A brief summary is given of research and development projects including nuclear instrumentation, accelerator operation and maintenance, experimental nuclear physics, radiation chemistry, isotope geochemistry with stable isotopes, carbon-14 variations, tritium in environmental waters, K–Ar age determination, fallout, isotope applications, and equipment and electronics development. (C.E.S.)

49038 (INS-TL-111) CONTROL SYSTEM OF GONIOMETER FOR IN-BEAM SPECTROSCOPY. Kusakari, Hideshige; Yoshikawa, Nobuharu; Ishii, Kameo; Kawakami, Hirokane; Ishihara, Masayasu (Tokyo Univ. (Japan). Inst. for Nuclear Study). Jun 1971. 14p. (In Japanese). Dep. NTIS (U. S. Sales Only).

A goniometer and its control system were designed and manufactured for in-beam gamma-ray spectroscopy. Electronic circuits of this control system were designed to fit with the multichannel pulse height analyser. The goniometer system co-operates with a beam monitoring system in order to minimize an effect of fluctuation of beam current during data taking. A series of measurements at several detection angles can be carried out repeatedly. (auth) (Japan)

49039 (RDT-C-4-5-T(Rev.)) PERMANENT MAGNET FLOWMETER FOR LIQUID-METAL PIPING SYSTEMS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Aug 1971. 24p. LMEC.

A standard prescribing requirements for the design, fabrication, testing, and inspection of a permanent magnet flowmeter for liquid-metal service is presented. (W.H.K.)

49040 MEASUREMENTS IN AN INHOMOGENEOUS FIELD WITH A RECTANGULAR HALL PLATE: ERRORS INTRODUCED BY SIZE EFFECTS ON THE PERPENDICULAR COMPONENT. Turck, B. (CEN, Gif-sur-Yvette, France). Nucl. Instrum. Methods; 95: No. 2, 205-7(1971).

The component in the plane of the probe, although parallel or perpendicular to the current (two components only), introduces errors in evaluating the component perpendicular to the plate, when the calibration curve taken in a purely perpendicular (homogeneous) field is used directly. (auth)

49041 RAY TRACING CALCULATIONS ON A SPLIT-POLE MAGNETIC SPECTROGRAPH. Das, S.; Sarma, N. (Bhabha Atomic Research Centre, Bombay). Nucl. Instrum. Methods; 95: No. 2, 213-19(1971).

General equations for the median-plane and Z-direction motion of a charged particle through a magnetic field are derived. A computer program for tracing a set of three rays of given divergence and various momenta is developed, and the median-plane equation of motion is solved numerically by using the Runge–Kutta fourth-order integration method. Both fringing fields of the sharp cutoff (SCOFF) and extended (EFF) form are considered. The position of the virtual images, the final median-plane image distance, and the various first-order characteristics of the spectrograph, such as median-plane magnification, dispersion, reduced dispersion, aberration, and momentum resolution, are calculated. (auth)

49042 TIME-AMPLITUDE CONVERTER FOR THE NANOSECOND RANGE WITH PRELIMINARY PULSE SELECTION. Kryshkin, V. I.; Stibunov, V. N.; Fedorov, N. P. (Tomsk Polytechnic Inst., USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 6, 1617-19(Nov-Dec 1970).

Translated from Prib. Tekh. Eksp.; No. 6, 64-6(Nov-Dec 1970).

A network is described which eliminates the recording of unpaired events and the overloading of the input amplifiers of multichannel amplitude analyzers, and provides for the possibility of control from a complementary pulse selection element; this allows a sharp reduction of the background from fast particles. (auth)

49043 SCALING NETWORK WITH COMMUTATION OF THE RESET THRESHOLD. Avdeev, V. A.; Kuznetsov, V. M. (Tomsk Polytechnic Inst., USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 6, 1620-1(Nov-Dec 1970).

Translated from Prib. Tekh. Eksp.; No. 6, 67-8(Nov-Dec 1970).

A scaling network with commutation of the reset cycles and parallel connection of two tunneldiode circuits is described. The network has a wide voltage range (±15% for ±10% tolerance for the scatter of the parameters of the components) and an increased speed of response (30 to 35 MHz). (auth)

49044 LINEAR GATES OF THE NANOSECOND RANGE. Ondrish, L.; Mukhin, S. V.; Rikhvitskii, S. V.; (and others). (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 6, 1630-2(Nov-Dec 1970).

Translated from Prib. Tekh. Eksp.; No. 6, 75-7(Nov-Dec 1970).

Linear gates of the nanosecond range constructed as a six-diode bridge circuit with linearity better than 1% in the amplitude range from 30 mV to 3.5 V are described. The maximum amplitude of the transmitted pulses is 5 V. The transfer constant is 0.9 in the linear region. The amplitude of the control pulses is 0.2 to 10 V. The gates do not have a pedestal. The overshoots at the start and end of the gates do not exceed 20 mV. (auth)

49045 MAGNETOMETER FOR MEASURING CONSTANT AND PULSED MAGNETIC FIELDS. Vasil'ev, M. P.; Gorelkin, A. S.; Luzhanskii, S. M.; Mozin, I. V.; Smirnov, V. P. (Scientific-Research Inst. for Electrophysical Apparatus, Leningrad). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 6, 1758-60(Nov-Dec 1970).

Translated from Prib. Tekh. Eksp.; No. 6, 182-5(Nov-Dec 1970).

A magnetometer using a Hall transducer for measuring constant and pulsed magnetic fields in the induction range of B = 0.01–2.0 T with an error no greater than ± (0.05% B ± 10^{-4} T) is described. The Hall emf is measured using a compensation method. High measurement accuracy is obtained by thermostatting the Hall transducer and using relative stabilization of the transducer current and the current exciting the Hall emf compensation circuit. (auth)

49046 ION SOURCE FOR THE MI-1305 MASS SPECTROMETER. Rat'kovskii, I. A.; Butylin, B. A.; Novikov, G. I. (Belorussian Technological Inst., Minsk). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 6, 1815-16(Nov-Dec 1970).

Translated from Prib. Tekh. Eksp.; No. 6, 223-4(Nov-Dec 1970).

An accessory ion source attachment for the MI-1305 mass spectrometer, to facilitate investigations of evaporation of difficult-to-volatilize materials under conditions close to thermodynamic equilibrium, over the temperature range from 600° to 2500°K, is described. (auth)

49047 IMPURITY PRECIPITATION AND DISSOLUTION RATES IN SODIUM PLUGGING INDICATORS. Biery, John C.; McPheeters, Charles C. (Los Alamos Scientific Lab., N. Mex.). Chem. Eng. Progr., Symp. Ser.; 66: No. 104, 107-15(1970).

Data collected at Los Alamos Scientific Laboratory and five other sodium research installations indicate that plugging indicators can detect up to three impurities in a sodium system and can determine their saturation temperatures. The indicators were operated in the partially plugged oscillating mode when these determinations were made. Flow and temperature changes from the plugging indicator were used to calculate mass transfer coefficients. The coefficients gave indications of nucleation characteristics of the impurity on the orifice. Also, these calculations may help in identifying species in a multi-impurity system from their precipitation and dissolution kinetic behavior in the plugging indicator. (auth)

49048 EVALUATION AND CALIBRATION OF THE UNC CARBON METER IN SODIUM. Rodgers, Sheridan J.; Shreve, Robert J. (MSA Research Corp., Evans City, Pa.). Chem. Eng. Progr., Symp. Ser.; 66: No. 104, 135-40(1970).

The results of the first field testing and calibration of a UNC carbon meter are presented. A description of the principle of operation and the operating characteristics of the meter is given. Effects of various operating parameters on the performance of the meter are discussed and recommendations on control of these parameters are presented. Techniques of calibration using Type 304 stainless steel monitoring tabs to measure the carburizing potential of the system are described. The method of adjusting the carburization potential of the system is described, also. A calibration curve of carbon sorption rates by stainless steel vs. carbon meter flux is given. (auth)

49049 PRESENT SITUATION OF THE INDUSTRIAL APPLICATION OF NUCLEAR INSTRUMENTS IN THE SOVIET UNION. Rozsa, Sandor (Inst. of Isotopes, Budapest). Atomtech. Tajek.; 13: No. 7, 465-7(1970). (In Hungarian).

Recently built plants increased greatly the capacity of the Soviet nuclear instrument industry; in 1969 about ten times more isotopic measuring instruments have been fabricated than in 1961. It is estimated that about 30,000 to 40,000 instruments are currently in use. A variety of instrument types, such as relay devices for level indication, thickness gages, density measuring devices, instruments for measuring coating thickness, moisture content measuring instruments, concentration and mass composition analyzers, industrial activation analysis instruments, field instruments for geophysical measurements, static charge removals, etc. are manufactured serially on a large scale. As an example of the wide spread usage, it is mentioned that at the Likhachov automobile plant 200 isotopic instruments are used; the Slavgorodskov chemi-

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cal plant uses 9 continuous level indicators and 32 γ related devices The metallurgical industry also makes use of many instruments. Progress has been made in automating industrial processes by means of isotopic instrumentation. Micro-miniaturization, development of functional units, and use of instruments for process control represent the current trends in design. (TTT)

49050 GENERATOR AND METHOD FOR TESTING THE RESOLVING POWER OF TIME ANALYZING DEVICES. Van Zurk, R. (CEN, Grenoble, France). Nucl. Instrum. Methods; 95: No. 1, 173-6(1971). (In French).

A generator and a method that facilitate the study of the resolving power of time analyzing devices are described. The generator delivers periodically, on different outputs, pairs of electrical pulses separated by a time interval, taking alternatively two distinct values, defined at better than 1.7 ps. The difference between these time intervals is adjustable in a range of a few ns. (auth)

49051 HIGH-FREQUENCY TRANSITIONS FOR POLARIZING LITHIUM NUCLEI. Holm, U.; Ebinghaus, H. (Univ., Hamburg). Nucl. Instrum. Methods; 95: No. 1, 39-44(1971). (In German).

High frequency transitions between Zeeman sublevels have been constructed by the application of the "fictitious spin $\frac{1}{2}$ system." The transition rates were measured by use of two sextupole magnets. Their dependence on different parameters is compared with theoretical predictions. Special high frequency transitions are designed for polarizing ^{7}Li with a nuclear spin $\frac{3}{2}$. (auth)

49052 FAST ACTIVE LINEAR GATE. Avrahami, Z.; Grinberg, J.; Seidman, A. (Tel-Aviv Univ., Israel). Nucl. Instrum. Methods; 95: No. 1, 61-7(1971).

A very fast active linear gate based on the principle of feedback was developed, built and tested. It is an improvement over the conventional passive linear gates on most figures of merit. For input signals with rise and decay times of 1 nsec, considerable improvement in feedthrough, gain-stability, linearity, dc stability, transients and pedestal level was achieved. (auth)

49053 OSCILLOSCOPE WAVEFORM DIGITIZER. Swoboda, C. A.; Daniels, R. E.; Maschke, A. W. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 369-70(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The instrument presented utilizes an oscilloscope, vidicon camera and control logic to digitize high speed transient or repetitive waveforms displayed on the CRT of an oscilloscope. It allows visual study of signals which would normally be degraded by the cabling used to carry the signal from the source to a remote oscilloscope. The instrument is placed near the source where digital conversion of the waveform takes place. The digital data is stored in local memory and is transmitted to a computer for manipulation and presentation. This allows long term study of transient waveforms. The unit extends the analog to digital conversion speed to 25 samples in 20 nanoseconds. Assuming 5 samples per cycle, this would correspond to digitizing transients in the 250 MHz frequency range. (auth)

49054 HIGHLY OVERVOLTED GAS SPARK GAPS FOR ELECTRON BEAM GENERATORS. Bradley, Laird P. (Sandia Labs., Albuquerque, N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 477-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A new approach to spark gap design is detailed. An avalanche-streamer theory is developed for highly overvolted, pressurized gas gaps, including preionization and direct ionization of the gas volume. Good agreement is obtained for theory and experiment using nitrogen. This theory is applied to the design of compact, low-inductance switches. An avalanche is started in a uniform field gap by an initiating electron or by intentional field distortion. At high values of E/p the avalanche converts to a streamer which crosses the gap slower than the avalanche. Introduction of volume ionization into the gap accelerates the streamer. The streamer velocity varies with the initial electron density. Proper selection of parameters reduces the streamer transit time by orders of magnitude to nanosecond times. Formulae are given which permit the design of highly overvolted gaps in uniform or near uniform field geometries. These provide reduction of inductance and size over normally designed gaps. (auth)

49055 SPIN–FLIP-SELECTOR FOR POLARIZED NEUTRONS. Papp, R.; Rauch, H. (Oesterreichische Hochschule, Vienna). Nucl. Instrum. Methods; 96: No. 1, 29-33(1971).

The electronic neutron spin-flip-selector results from the combination of two electronic spin-flip-choppers running at a certain distance with an adjustable phase difference. The neutron velocity distribution can be determined from the neutron intensity behind the analyzer. Such an instrument is tested for a monochromatic neutron beam and the results demonstrate the high resolution obtainable. The experimental and computed results correspond very well. (auth)

49056 DATA ACQUISITION SYSTEM WITH MASS STORAGE. Van Elswijk, P. B. J.; Engmann, R.; Hoogenboom, A. M.; de Wit, P. (Rijksuniversiteit, Utrecht). Nucl. Instrum. Methods; 96: No. 1, 35-41(1971).

A data handling system consisting of a small computer with disk storage and magnetic tape has been developed for various kinds of nuclear spectroscopy experiments. The operator can specify the data structure and parameters of the experiment in a suitable code to the computer. (auth)

49057 MEAN VALUE POSITION CALCULATOR UNIT FOR PULSE-HEIGHT ANALYZERS. Sidenius, G. (Univ. of Copenhagen). Nucl. Instrum. Methods; 96: No. 1, 1-2(1971).

A description is given of a simple and cheap electronic unit, which fastens and exactly calculates the mean-value position of a selected peak from a pulse-height spectrum during the accumulation of the total spectrum. The shape of the peak has no influence on the accuracy of the calculation. (auth)

49058 PRECISION GONIOMETER FOR USE IN CLEAN VACUUM CONDITIONS. Cairns, J. A.; Benneworth, B.; Yeates, R. C. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods; 96: No. 1, 89-91(1971).

The new goniometer described here is compatible with clean high vacuum systems, and can be controlled remotely in a precise manner. It exhibits complete rotation about two mutually perpendicular axes, with provision for a third (tilt) axis, its movements being activated by stepping motors located outside the target chamber. Since all of the movements are transferred through a single flange, the goniometer offers the advantage of ready incorporation into a variety of target chamber designs. (auth)

49059 ANALOG-DIGITAL FAST TIMING WITH LOW ENERGY PARTICLES. Birchall, J.; Frois, B.; Roy, R.; Slobodrian, R. J. (Univ. Laval, Quebec). Nucl. Instrum. Methods; 96: No. 1, 45-9(1971).

A simple technique has been used to improve timing resolution and noise rejection in coincidence experiments obtainable with time pick-off and solid state detectors. Walk has been reduced typically from 50 ns to less than 1 ns for α particles of energies between 0.5 to 10 MeV. The technique is of special interest to increase the true to random coincidence ratio between two detectors. (auth)

49060 PULSE GENERATOR OF VARIABLE POWER AND DURATION. Ahrweiller, M. (CEN de Saclay, Gif-sur-Yvette, France). Nucl. Instrum. Methods; 96: No. 1, 205-8(1971). (In French).

Pulsed power generators producing pulses of adjustable amplitude, duration and frequency are described. Each parameter may be varied separately and continuously. The peak power can reach an energy equal to 1 megawatt. The particular problems involved by the construction of a delay line generator are discussed in great detail. These instruments which have been designed for experiences in atomic and plasma physics might also be very useful in many other related fields. (auth)

49061 TIME-OF-FLIGHT SPECTROMETER FOR HEAVY IONS. Gelbke, C. K.; Hildenbrand, K. D.; Bock, R. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Instrum. Methods; 95: No. 3, 397-402(1971).

A time-of-flight spectrometer for the identification of complex nuclei produced by nuclear reactions with heavy ions has been constructed. The transmission detector consists of a thin scintillator foil; the stop signal and the energy information are derived from a surface barrier detector. A time resolution of better than 0.3 ns has been obtained. The system is able to separate masses up to A = 40 at energies below 3 MeV/amu. (auth)

49062 STUDY OF THE HEUSLER ALLOY (Cu_2MnAl) AS MONOCHROMATOR FOR POLARIZED NEUTRONS. Delapalme, A. (CEN, Grenoble, France); Schweizer, J.; Couderchon, G.; Perrier de la Bathie, R. Nucl. Instrum. Methods; 95: No. 3, 589-94(1971). (In French).

The possibility of using Heusler alloy as monochromator for polarized neutrons is presented; the crystalline structure depends on the heat treatment and this property can be used to adjust the mosaic of the monochromator. The results are compared with those obtained with an Fe–Co monochromator in a double axis

experiment. The minimum gain of the counter intensity is 2.5 and a beam polarization of 0.96 has been attained. (auth)

49063 MULTICHANNEL NUMERICAL ULTRA-FAST SAMPLER FOR EXTRACTION OF THE SIGNAL FROM BACKGROUND NOISE. Fernandes, C. (CEN de Saclay, Gif-sur-Yvette, France). Nucl. Instrum. Methods; 95: No. 3, 497-507 (1971). (In French).

The apparatus described allows the extraction of a repetitive synchronized signal from a random stationary basic noise. Because of special characteristics of signal-noise, from a physics experiment (study of plasma instabilities, gas ionization by a laser beam), this extraction is performed with a multichannel sampling followed by addition in a digital memory. This apparatus extracts 16 samples (minimum interval between each sample: 10 ns) of a signal, the amplitude of which may vary in a ratio of 1 to 500 with a signal-to-noise ratio possible improvement of 700. (auth)

49064 BISTABLE SYMMETRICAL PHOTOMULTIPLIER GATE USING INTEGRATED CIRCUITS. Fullwood, R. R. (Los Alamos Scientific Lab., N. Mex.). Nucl. Instrum. Methods; 95: No. 3, 509-13(1971).

A bistable symmetrical gate for photomultiplier types RCA 4522 and RCA 8575 is presented. Six dynodes are directly employed in the gating in a symmetrical fashion, tending to cancel the gating transient. Gate duration of 0.5 μsec to ∞, and repetition rates to 100 kHz are available. The effectiveness of the on-off gating was not measured, but a limit of greater than 1000:1 can be stated. The rise-time is 20 nsec; the gain is low by 8% immediately upon turn-on and reaches its dc value in about 0.3 μsec. (auth)

49065 EFFECT OF FINITE SOURCE SIZE ON BEAM FOCUSSING IN A CYLINDRICAL-FIELD ELECTROSTATIC SPECTROMETER. Zashkvara, V. V.; Korsunskii, M. I.; Lavrov, V. P Red'kin, V. S. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 1, 141-5(Jul 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 1, 187-92(Jan 1971).

The effect of the finite size of a charged-particle source on image quality in an electrostatic spectrometer with a cylindrical field with second-order angular focussing is considered. Estimates of resolution, transmission, and emittance are given. The ion-optics of the cylindrical spectrometer are compared with those of a spherical condenser. (auth)

49066 FOCUSING OF A BEAM OF CHARGED PARTICLES WITH FINITE ANGULAR DIVERGENCE IN A CYLINDRICAL-MIRROR ELECTROSTATIC ANALYZER. Zashkvara, V. V. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 1, 146-9(Jul 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 1, 193-7(Jan 1971).

The ion-optical characteristics of a cylindrical-mirror charged-particle energy analyzer which produces optimal angular focusing of a beam of finite angular divergence on the axis of symmetry are determined. (auth)

49067 PRISM MASS SPECTROMETER WITH ENERGY FOCUSING. Kel'man, V. M.; Rodnikova, I. V.; Finogenov, P. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 1, 130-5(Jul 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 1, 173-9(Jan 1971).

The construction and operation of a prism mass spectrometer with energy focusing are described. Energy focusing is achieved by a combination of magnetic and electrostatic prisms. Spatial focusing is accomplished with electrostatic lenses. The maximum tested value of the resolving power, calculated from the widths of the peaks at half-maximum, is $13-14 \cdot 10^3$. A number of mass spectra are presented. (auth)

Radiation Effects on Instruments and Instrument Components

Refer also to abstracts 49575, 49578, 49589, 49590, 49975, 49976, 50459, 50462, and 50596.

49068 (N-70-25005) LOW-ENERGY PROTON EFFECTS ON SOLAR CELL COVER GLASS MATERIALS. VOLUME 1. Final Technical Report. Lillywhite, Malcolm A. (Martin Marietta Corp., Denver, Colo. Research Dept.). Nov 1969. Contract NAS2-5083. 24p. (NASA-CR-73372). NTIS.

The stability of the spectral transmission in the .3 to 2.2 micron spectral region of solar cell cover glass materials when exposed to the simulated solar wind proton environment has been evaluated. The test specimens were irradiated with 2 and 3 keV protons separately and combined with simulated solar electromagnetic radiation. Proton fluxes were nominal 2×10 to the 11th power p/sq cm sec where fluences of 5×10 to the 17th power p/sq cm were obtained. The materials irradiated include 0211 microsheet and 7940 fused silica with and without MgF_2 antireflective coatings and were tested at 140, 300 and 400 K. Samples of these materials were irradiated in a clean vacuum system, intentionally contaminated with 704 diffusion pump condensate, and then placed in a clean vacuum system for irradiation. A model is presented which attempts to explain discrepancies in reported proton damage to MgF_2 and is based on a contaminant film build-up on the MgF_2 surface. No optical damage was observed in the spectral region specified for any material tested under a combination of test conditions. X-ray diffraction characterization showed, however, that the crystallinity of the MgF_2 thin film was altered by irradiation but no optical damage correlation was possible. (auth) (STAR)

49069 (SC-DC-70-5386) NEUTRON INDUCED DEGRADATION AND FAILURE IN HIGH POWER LSA DIODE OSCILLATORS. Wilson, W. E.; Gregory, B. L. (Sandia Labs., Albuquerque, N. Mex.). [1971]. 10p. Dep. NTIS.

The effects of neutron irradiation on oversized epitaxial gallium arsenide diodes operated in the LSA relaxation mode are discussed. The expected material degradation effects are related to circuit performance by use of a simplified circuit analysis which neglects starting and harmonic effects. The experimentally determined material and oscillator characteristics are then reported for diodes having two different initial doping concentrations. These results are compared to the theory to obtain general conclusions about the radiation effects on LSA oscillators. (W.H.K.)

49070 EFFECTS OF RADIATION ON SUPERCONDUCTING Nb/Ti Wire. Hassenzahl, W. V. (Los Alamos Scientific Lab., N. Mex.); Rogers, J. D.; Armstrong, W. C. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 683-4(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Commercial Nb–Ti superconducting wires were irradiated with 13-MeV protons at the Los Alamos Tandem Van de Graaff. Integrated fluxes up to 10^{18} protons/cm^2 were attained after several one-day irradiations. The effects of radiation on short sample critical current was studied for three different irradiation temperatures. Samples were maintained at 300 K by water cooling, at 100 K by liquid nitrogen cooling and 20 to 30 K in a liquid helium bath. The resistance previously observed after low temperature irradiations was not seen. However, short sample critical currents were reduced slightly in samples irradiated below room temperature. (auth)

49071 RADIATION RESISTANCE OF ORGANIC MATERIALS AT CRYO-TEMPERATURES. Van de Voorde, M. H. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 784-5(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Organic materials and components play an important role in the construction of cryogenic and superconducting magnets which have to be operated in high energy accelerators e.g., for structural components, insulators, etc. Materials used for these applications must retain good mechanical and electrical properties at low temperatures in a radiation environment. As organic materials are the least radiation resistant components used in magnet construction, they determine the life-time of the magnet. In order to obtain an acceptable life for the machine, special care must therefore be given to the selection of these materials. Experiments performed to determine the radiation behavior of a number of thermosettings, thermoplastics, and elastomers at cryo-temperatures are described. The experimental procedures, the irradiation conditions and the first results are reported. The results refer especially to recently developed materials. (auth)

49072 CLEARING RADIATION DARKENED TV LENSES. Reigle, Donald L. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 837-8 (Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The TV lenses used in high radiation areas at the Zero Gradient Synchrotron (ZGS) become very brown and totally unusable within a short period of time. A method has been found whereby rotation of lenses from this area to exposure by UV light can keep a constant supply of usable lenses in service. Tests were also conducted on ZGS TV viewing ports to determine the clearing effect of UV on 3/4-in, 1-in, and 4-in-thick plate glass. (auth)

XUM

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Basic Processes

49073 MEASUREMENT OF CELL MEMBRANE KINETICS. Scott, Kenneth Gordon. British Patent 1,239,447. 14 Jul 1971. Priority date 14 Jul 1967, United States.

An apparatus for studying the kinetics of cell membrane transfers for radioactive cations in blood plasma in the presence of red blood cells is composed of an elongated member comprising a pair of chambers, each adapted to contain a blood sample. A cation resin is contained in one of the chambers, and the chambers are connected by a conduit to allow the sample to pass from one chamber to another. The second chamber contains a ^{86}Rb source. Using this apparatus to monitor the passage of the radioactive cations across the cell membrane both active and passive rates of cation transport by cells can be measured. Data from studies using this apparatus are applicable to research on cancer, heart disease, anemia, and schizophrenia. (B.L.M.)

49074 SIMPLIFIED METHOD FOR RADIOIMMUNOASSAY OF ENZYME SYSTEMS. APPLICATION ON THE HUMAN RENIN-ANGIOTENSIN SYSTEM. Poulsen, Knud (Univ. Inst. for Experimental Medicine, Copenhagen). J. Lab. Clin. Med.; 78: No. 2, 309-15(Aug 1971).

The method introduces a new field of application for radioimmunoassay. The principle consists of the presence of an excess of radioimmunoassay antibody during enzymatic incubation. The antibodies can capture an intermediate product such as angiotensin, formed with time, and, thereby, protect it against enzymatic degradation. Subsequent to the enzymatic reaction, the incubation mixture is diluted and labeled angiotensin is added simultaneously. Finally, free angiotensin is removed with charcoal, and counting of the antibody-bound angiotensin gives the amount of captured angiotensin with an accuracy of ±4% (S.D.). The method is simple, and the whole procedure, except for the counting, is performed in the same tube. The renin activity for normal persons was 1.1 (0.39 to 1.94) ng per ml per hour. The same principle was used for the determination of the renin concentration, finding values of 0.48 (0.28 to 0.80) $\times 10^{-4}$ Goldblatt units (GU) per ml. (auth)

49075 BIOLOGICAL HALF LIFE OF RADIOELEMENTS IN INSECTS. Buscarlet, L. A. (CEA, Saint-Paul-les-Durance, France). Ann. Zool. Ecol. Anim.; 2: No. 3, 451-70(1970). (In French).

The biological half life of radioelements in insects was studied. The definition of the biological half life is given; ecological applications of labeling and internal and external factors affecting the biological half life are discussed. The different species studied are presented in a synoptic table which indicates: the radioelement used, the parameters affecting the rate of elimination, and the biological half lives obtained. (France)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 49154 and 49285.

49076 (AD-715423) RETENTION OF NEAR-IN FALLOUT BY FIELD CROPS AND LIVESTOCK. Final Report. Johnson, James E.; Lovaas, Arvin I. (Colorado State Univ., Fort Collins. Dept. of Animal Science). Nov 1970. Contract DAHC20-68-C-0120. 53p. NTIS.

Near-in fallout as simulated by lutetium-177 labeled sand in size ranges 88-175 and 175-350 microns was dispersed over field crops and grazing animals and fed to sheep and cows. Initial retention and weathering half time were measured for alfalfa, corn, barley, bromegrass, sudan grass, sugarbeet tops and cows' backs. Residence times for the sand in sheep and cow digestive tracts were determined. (auth)

49077 (ANL-Trans-898) COMPLEX FORMATION OF NATURAL URANIUM IN THE BLOOD. Chevari, S.; Likhner, D. Translated for Argonne National Lab., Ill., from Med. Radiol.; 13: No. 8, 53-7(Aug 1968). 8p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 49208.

49078 (COO-1784-24) STUDY OF THE PHYSIOLOGICAL FUNCTION AND HISTOLOGICAL CHANGES IN THYROIDS IRRADIATED WITH RADIOACTIVE IODINE. Summary Report, August 1, 1951-June 1, 1971. Dobyns, Brown M. (Case-Western Reserve Univ., Cleveland, Ohio. School of Medicine). 30 Jun 1971. Contract AT(30-1)-1243. 35p. Dep. NTIS.

Studies were conducted on the development and use of column chromatography for the separation of iodinated amino acids; hydrolysis of thyroid tissue for the quantitative recovery of iodinated compounds; the use of ^{14}C labeled tyrosine to explore the synthesis of thyroid hormones; paper chromatography of iodinated compounds; cellular changes in human thyroids treated with ^{131}I; changes in cellular structure and function in thyroids of rats following ^{131}I radiation; biochemical changes resulting from a single therapeutic dose of ^{131}I in man; contribution of the ^{131}I kinetics data of the Public Health Service follow-up study; disappearance of ^{131}I from the thyroid following a therapeutic dose of ^{131}I; mono- and diiodotyrosine in the circulation following ^{131}I therapy for hyperthyroidism; the use of paper electrophoresis to study the iodinated proteins and polypeptides in the circulation following ^{131}I therapy; the role of triiodothyronine in hyperthyroidism; the measurement of DNA in individual thyroid cells previously subjected to ^{131}I radiation; bizarre nuclear forms in human thyroid tissue and measurement of DNA in them; the use of tritiated thymidine to study the mitotic activity in irradiated thyroids; anomalies of chromosomes in circulating leukocytes in man following large doses of ^{131}I; peroxidase in thyroid and other tissues; effects of x radiation on the thyroid; life of the normal thyroid cell and its potential for replication as compared to the irradiated thyroid cell; observations on the development of thyroid nodules in populations exposed to radioiodine fallout in the Marshall Islands and in the Utah-Nevada fallout area; spontaneous goiters arising in offspring of mothers previously treated with ^{131}I; identification of subtle morphologic effects of ^{131}I on the thyroid; and development of neoplasms in irradiated animal and human thyroids. (H.L.W.)

49079 (NP-18974) INVESTIGATION OF TRITIATED LUMINOUS COMPOUNDS. Kaufman, Stephen L.; Colvin, Mayme C.; Lieberman, Robert; Moghissi, A. A.; Rehnberg, Blair F.; McMillan, Robert C. (Eastern Environmental Radiation Lab., Montgomery, Ala.). Jun 1971. 13p. (EERL-71-2).

The cutaneous and gastrointestinal tract absorption of four tritiated luminous compounds was studied in cats and rats. The percent absorption of the individual compounds via the cutaneous route varied from 0.10 to 8.83 percent and via the gastrointestinal route from 0.67 to 21.55 percent. The data show a positive correlation between the relative absorption of the individual luminous compounds through both the cutaneous and gastrointestinal routes. Tritium activity was eliminated in two components. A slow component was seen to represent tritium activity in the form of tritiated water (HTO), while a more rapid component was thought to be tritium incorporated in other compounds soluble in urine and other body fluids. (auth)

49080 (UCLA-12-815) ANNUAL PROGRESS REPORT FOR PERIOD ENDING JUNE 30, 1971. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). Contract AT(04-1)-Gen-12. 165p. Dep. NTIS.

Separate abstracts were prepared on four sections of this report. (C.H.)

For abstracts of individual sections see: 48542, 49099, 49120, and 49225.

49081 EXCRETION OF RADIOACTIVE IODINE IN THE MILK OF RUMINANTS. Daburon, F.; Romain, J.; Tricaud, Y.; Nizza, P. (CEA, Jouy-en-Josas, France). Lait; 51: No. 501-502, 8-22(Jan-Feb 1971). (In French).

After a short account of the results obtained on the iodine excretion balance in lactating ewes and cows, the physicochemical, physiopathological, and pharmacodynamic factors that may influence the transfer of iodine into the milk are reviewed. The respective variations of the percentages of ionic and milk-protein-bound iodine are studied with respect to the different parameters; several assumptions concerning the origin of the organic fraction are put forward. (auth)

49082 STUDIES WITH RADIOTHORIUM(^{228}Th) ENRICHED THORIUM DIOXIDE AND ITS RADIOACTIVE PROGENY. Ballou, John Edgerton. Rochester, N. Y.; Univ. of Rochester (1969). 207p. University Microfilms Order No. 71-14,555.

Thesis.

The ^{224}Ra and ^{212}Pb daughters in ThO_2 were preferentially solu-

bilized and translocated from deposits of the oxide in muscle, in the major reticuloendothelial organs and from the lung air space and vascular system. The extent of the washout varied with the primary site of ThO_2 deposition, but as a rule the lead isotope was depleted (relative to ^{228}Th) to a twofold greater extent than its radium precursor. A major portion of the ^{212}Pb deficit (40 ± 9% of that washed from an inhaled deposit in lung) could be attributed to loss of the immediate parent of ^{212}Pb, thoron, in the expired air. The balance of the translocated ^{212}Pb accumulated in red blood cells and liver in the ratio of 5:1, respectively. The concentration of ^{212}Pb in blood appeared to reflect the amount of ThO_2 in the dog, regardless of deposition site, and maintained a ratio of blood $^{212}Pb(nCi/g)/lung\ ^{228}Th(\mu Ci) = 0.083 \pm 0.027$ over a retention period from 3 to 150 days. For 11 dogs exposed to inhaled ThO_2 the ratio was 0.084 ± 0.012 over the same retention period. The ^{224}Ra washed from ThO_2 deposits accumulated in bone (~90%) or was excreted (~5%) in the ratio urine/feces = 0.5. Radium-224 in bone was depleted in ^{212}Pb ($^{212}Pb/^{224}Ra = 0.8 \pm 0.05$) due to the combined losses of thoron by diffusion and ^{212}Pb by mobilization. The depletion of ^{212}Pb in bone was obvious by the third day after inhalation of ThO_2. Thoron was released into the lung space from inhaled ThO_2 to the extent of 18 ± 3% of that produced by the ^{224}Ra in lung. Thoron release was approximately one-half this value from deposits in lung that originated from systemically injected ThO_2; even less was released from primary deposits of ThO_2 in muscle. The relative concentration of ^{228}Th, ^{224}Ra and ^{212}Pb in tissues at "steady state" was expressed in terms of the initial LRT burden extrapolated from the long-term clearance phase. These concentrations of the daughters were discussed in terms of their application to the estimation of industrial exposures to ThO_2 and the calculation of radiation dose subsequent to ThO_2 incorporation. (Diss. Abstr. Int., B)

49083 FATE OF INHALED $^{152\ 153\ 154}$EUROPIUM OXIDE IN THE RAT. Johnson, Raleigh Francis Jr. Lafayette, Ind.; Purdue Univ. (1969). 169p. University Microfilms Order No. 71-17,934.

Thesis.

A small animal inhalation experiment was designed to expose albino rats to an aerosol of radioactive europium oxide. The experimental animal investigation was initiated following a study of an inhalation exposure at Purdue University of two male, human subjects to an accidental airborne release of radioactive europium oxide. The inhalation exposure of small animals to a radioactive aerosol of Eu_2O_3 was accomplished in a controlled, closed system. Whole body retention analyses were accomplished for the average per cent retention values observed at various time intervals for all the animal groups. The retention data were described by two mathematical models. A dual component exponential function of the form $A = 76.11e^{-1.562t} + 23.89e^{-0.023t}$ closely characterized the retention of $^{152-154}Eu$. Half time values calculated from the short and long term components of the exponential model were 0.44 day and 30.12 days respectively. A second mathematical model describing the retention of radioeuropium in the rat was a power function of the form $Y = 45.18t^{-0.389}$. The average lung burden after 30 days was determined to be 4.8 ± 1.3% of the initial whole body burden per gram of lung tissue. Other tissues and organs were found to have no significant activity at the 95% level of confidence for 5% counting error. The minimum detectable sensitivity for sample counting was about 3% of the average initial body burden of the 30 day exposure group of animals. Translocation of $^{152-154}Eu$ from the lung to other parts of the body was not significant at 30 days following inhalation of Eu_2O_3. Daily excreta samples were counted and all the urine data indicated no significant activity. After three days, the fecal radioactivity was not significant at the 95% level of confidence for a 5% error. Fecal radioactivity accounted for nearly 100% of the excreted $^{152-154}Eu$. (Diss. Abstr. Int., B)

49084 QUANTITATIVE STUDY OF STRONTIUM METABOLISM IN BONE. Talisayon, Serafin Demandante. Ithaca, N. Y.; Cornell Univ. (1971). 116p. University Microfilms Order No. 71-672.

Thesis.

An improved strontium balance equation or prediction model is proposed and validated experimentally in this study. The equation proposed is: $Sr_n = (1\text{-}f')Sr_{n-1} + r'\,[Sr_n - (1\text{-}f')Sr_{n-1}] + OR_{bone\text{-}diet}\,Z[(1\text{-}r)\,Ca_n - (1\text{-}f)Ca_{n-1}]$. Sr_n stands for total elemental strontium in the skeleton at time t_n. The first term on the right side represents strontium not resorbed or exchanged between t_{n-1} and t_n. The amount of newly-deposited strontium is accounted for by the second term which represents reutilized or recycled strontium or that strontium which left the bone pool between t_{n-1} and t_n and returned by time t_n, and the third term which represents strontium from the diet. As compared to existing models, the equation involves more parameters of skeletal metabolism and illuminates in greater detail the input and output movements of strontium and calcium to and from bone. Rather than rely on the goodness-of-fit criterion, every quantity entering into the equation is measured experimentally on the same experimental animal and the equation tested for balance and consistency. Experimental results indicate that: strontium enters and exits bone faster than does calcium, a finding which is consistent with and offers a theoretical explanation for several observations on strontium and calcium tracer behavior in bone reported by other investigators; young pigs reutilize or recycle resorbed strontium and calcium very efficiently, reutilization efficiency decreasing steadily with age; and the proposed strontium balance equation is internally consistent and when all experimentally-measured skeletal parameters are substituted into the equation, good balance is obtained (1.4% error). If physiologically meaningful parameters of skeletal metabolism of strontium and calcium are to be derived from regression coefficients in ^{90}Sr prediction equations, an equation previously validated experimentally such as the strontium balance equation proposed here should be employed. For this purpose, it is also suggested that the gross growth regions such as the sub-epiphyseal layer in long bones be included in the routine assay of ^{90}Sr. The additional data are shown to yield more meaningful information from present population surveys and analyses of fallout ^{90}Sr in human bones and diet. (Diss. Abstr.)

49085 ION PERMEATION IN Th^{4+}-TREATED RABBIT GALL-BLADDER EPITHELIUM. Machen, Terry Evan. Los Angeles; Univ. of California (1971). 201p. University Microfilms Order No. 71-16,387.

Thesis.

When rabbit gall-bladder was bathed in pH 7 solutions, the epithelium was more permeable to cations than to anions; when solutions maintained at pH 3 by 2.5 mM $Th(NO_3)_4$ bathed the gall-bladder, the membrane became more permeable to anions than to cations. Ion permeation in gall-bladders bathed in these Th^{4+} solutions was studied electrically by measuring transepithelial electrical potential differences, conductances, and current-voltage relationships. Light and electron micrographs indicated that under the low pH bathing solution conditions, the gall-bladder cells were morbid but that the cell membranes and junctional complexes remained intact. The anion permeability sequence as determined from bi-ionic potentials measured after 25 minutes bathing time in the Th^{4+} solutions was $SCN^- > ClO_4^- \geq I^- \sim NO_3^- > Br^- \sim ClO_3^- > Cl^- > BrO_3^-$. A comparison of this sequence to theoretically predicted sequences for the halide anions indicated that anion permeation in Th^{4+}-treated gall-bladders was controlled by membrane sites of weak field strength, but not so weak that the permeability sequence was the completely inverted order of the hydration energies with respect to all the ions tested. The Th^{4+} effect on gall-bladder permeability properties seemed to be a combination of the effects of H^+ ion and Th^{4+} ion (or transformation products) shielding membrane dipolar sites such that the predominantly negative environment was changed to a predominantly positive environment. The implication was that there was occurring a suppression of cation mobility and enhancement of anion mobility within the neutral channel, thus giving rise to the inversion of the anion-to-cation permeability ratio when pH 7 solutions were changed to Th^{4+}. Finally, the Th^{4+}-treated gall-bladder could be pictured schematically as a membrane thick enough that microscopic electroneutrality could not be violated. There were neutral and shunt channels in both of which the concentrations of anions and cations were nearly equal. Into the neutral channels projected negative ends of dipolar sites. H^+ and Th^{4+} shielded these sites such that there was a predominantly positive environment within the neutral channel; cation mobility was low, and anion mobility was high. The ions moved with free-solution mobilities within the shunt, the relative area (with respect to neutral channel) of which increases with time. (Diss. Abstr.)

49086 PROPERTIES OF ESCHERICHIA COLI GROWN IN DEUTERATED MEDIA. Mann, L. R. B.; Moses, V. (Univ. of California, Berkeley). Folia Microbiol. (Prague); 16: No. 4, 267-84(1971).

The effects on a number of parameters of transferring Escherichia coli between protonated and deuterated media were studied; these included growth, oxygen consumption and the synthesis of DNA, RNA, total protein, and β-galactosidase. Similar measurements were made on cells fully adapted to growth on deuterated media. The amino acid compositions of deuterated and protonated cellular protein were similar, but in deuterated cells the ratio protein: DNA was doubled. Deutero- and protio-β-galactosidase had similar K_M values and turnover numbers in D_2O and H_2O. The kinetics of β-galactosidase synthesis were not changed by deuteration, but it was found that lower concentrations of inducer were required to achieve particular levels of induction. Brief exposure to inducer in one medium, followed by removal of inducer and expression of enzyme-forming-potential in either D_2O or H_2O,

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showed that mRNA synthesized by deuterated cells was translated equally well in both media. mRNA synthesized by protonated cells was translated about twice as efficiently in H_2O. Inducible strains (but not a regulator constitutive) lost the capacity to synthesize enzymically active β-galactosidase after more than 100 generations in D_2O-acetate. The defect persisted when such cells were grown in H_2O-acetate, but enzyme activity was restored by growth in H_2O-glycerol. The failure to produce active enzyme was not due to a failure of the induction mechanism; gel electrophoresis revealed the presence of an inactive protein species. The nature of adaptation to deuteration is discussed. (auth)

49087 ACCUMULATION AND EXCRETION OF RADIOACTIVE CAESIUM BY THE PLAICE (PLEURONECTES PLATESSA) AND THE THORNBACK RAY (RAIA CLAVATA). Jefferies, D. F.; Hewett, C. J. (Ministry of Agriculture, Fisheries, and Food, Lowestoft, Eng.). J. Mar. Biol. Ass. U.K.; 51: No. 2, 411-22(1971).

The patterns of accumulation of ^{134}Cs by the organs and tissues of the plaice Pleuronectes platessa L., a marine teleost, and the thornback ray Raia clavata L., a marine elasmobranch, are described. Estimates of the biological half-time and steady-state concentrations in relation to sea water are derived using a simple exponential model. The rate processes are examined again in an experiment to measure the rate of loss of ^{134}Cs from fish after a period of accumulation. The biological half-time, at 10°C, for ^{134}Cs in the muscle of plaice of 30 g weight is estimated to be 120–140 days, and in rays of 80 g weight 180–190 days. In all other tissues and organs examined the rate processes in the plaice are faster than in the ray. Estimates are made of the amount of cesium obtained from water and from food. It is concluded that the plaice obtains at least 50% of its cesium body burden from food and the ray probably more than 80%. Cesium is absorbed from water via the gut in both species, but whereas in the plaice this accounts for up to 50% of the intake from water, in the ray this is probably a much smaller pathway. Excretion in both species appears to be 90% extrarenal. (auth)

49088 METABOLISM OF TANTALUM IN THE RAT. Fleshman, D. G.; Silva, A. J.; Shore, B. (Univ. of California, Livermore). Health Phys.; 21: No. 3, 385-92(Sep 1971).

Radiotantalum (^{182}Ta) administered orally to rats as potassium tantalate was excreted rapidly through the gastrointestinal tract. Less than 1% was retained in the body, and bone accounted for more than 40% of the body burden by the 14th day. Elimination followed a three-component curve; the biological half-time of the long-term component was 62 days in males and 119 days in females. Tantalum was present in the body in detectable amounts up to 106 days after exposure. (auth)

49089 LONG-TERM RETENTION OF INHALED ^{60}Co. Newton, D.; Rundo, J. (Atomic Energy Research Establishment, Harwell, Eng.). Health Phys.; 21: No. 3, 377-84(Sep 1971).

The behavior of ^{60}Co was studied in five men for periods of up to 11 yr after accidental inhalation of the irradiated metal or its oxide. It is concluded from body radioactivity measurements that long term clearance from the chest may be extremely slow, with observed biological half-lives of up to 17 yr, while for the clearance of systemic burdens of ^{60}Co, a value in the region of 7 yr is suggested. (auth)

49090 KINETICS OF CALCIUM, STRONTIUM, BARIUM, AND RADIUM IN RABBITS. Liniecki, Julian (Instytut Medycyny Pracy, Lodz, Poland). Health Phys.; 21: No. 3, 367-76(Sep 1971).

Short-term kinetics of calcium, strontium, barium, and radium were studied in adult rabbits using ^{47}Ca, ^{85}Sr, ^{133}Ba, and ^{226}Ra. The urinary and fecal excretion rates were determined as well as the magnitude of exchangeable pool (E) and skeletal addition-rate (A). The latter was several times larger for Ba and Ra than for Ca and Sr. The magnitude of the exchangeable space E was larger for Sr, Ba, and Ra than for Ca, roughly by a factor of 2 to 3. The metabolic kinetics of four alkaline earth elements in rabbits with that in other species is compared and possible reasons for the enlarged value of A for barium and radium discussed. (auth)

49091 COMPARATIVE METABOLISM OF RADIONUCLIDES IN MAMMALS. VII. RETENTION OF ^{106}Ru IN THE MOUSE, RAT, MONKEY, AND DOG. Furchner, J. E.; Richmond, C. R.; Drake, G. A. (Los Alamos Scientific Lab., N. Mex.). Health Phys.; 21: No. 3, 355-65(Sep 1971).

Whole-body retention of $^{106}RuCl_3$ as a function of time was measured in mice, rats, monkeys, and dogs. Retention after oral dosage and after parenteral injection was measured in the four species. About 4% of an oral dose was absorbed in the gastrointestinal tract, and about 20% of a parenteral dose was lost with an effective halftime of about 200 days. The highest concentrations were found in the kidney, while bone maintained about 6% of the body burden over a period of 8 months. Such values are compared with values in the literature. Estimates of the maximum permissible concentration in water were greater for the target organs examined than the limiting value of 10^{-4} μCi/cm³ set by the ICRP for the lower large intestine. (auth)

49092 EXPERIMENTAL STUDY OF THE DECONTAMINATION OF THE SKELETON AFTER INHALATION OF AMERICIUM NITRATE. Nenot, J. C.; Morin, M.; Lafuma, J. (CEA, Fontenay-aux-Roses, France). Health Phys.; 21: No. 3, 395-400(Sep 1971). (In French).

Contamination of the respiratory tract by ^{241}Am resulted in a body burden almost exclusively in the skeleton after a three week delay. An intensive treatment with DTPA was tried after this delay in order to evaluate the therapeutic efficiency of the chelating agent. The control animals still had a stable skeleton contamination four months after inhalation; however, the treated animals had a bone burden reduced by a factor of 1/3. At first, the urinary elimination of the treated animals had a double origin from the lung and the bone, and later exclusively from the bone. (auth)

49093 EFFECT OF TRACER DOSES OF ^{131}I ON SERUM PROTEIN-BOUND IODINE AND SERUM THYROXINE CONCENTRATION. Vagenakis, Apostolos G.; Abreau, Cynthia M.; Braverman, Lewis E. (St. Elizabeth's Hospital, Boston. Tufts Univ., Boston). J. Nucl. Med.; 12: No. 9, 637-8(Sep 1971).

Results of previous studies on the effects of tracer doses of ^{131}I on the secretion of the thyroid hormone into the blood are contradictory. Therefore, experiments were carried out on patients referred to the laboratory for studies of thyroid function. Blood was drawn before administration of the ^{131}I and 48 hr later. Both samples of serum were analyzed for stable PBI and for thyroxine iodine. It was found that the administration of ^{131}I in tracer doses of 15 to 60 μCi did not affect the serum PBI or serum thyroxine iodine. (H.L.W.)

49094 METHOD OF CORRECTING FOR THE ABSORPTION OF ^{14}C IN ANIMAL TISSUES. Edwards, G. A.; Jones, E. G.; Higginbotham, C.; Edwards, C. H. (North Carolina Agricultural and Technical State Univ., Greensboro). Int. J. Appl. Radiat. Isotop.; 22: No. 5, 309-11(May 1971).

A procedure is discussed to correct for self absorption of ^{14}C in thick samples, based on the measurement of self absorption in a selected tissue and comparison with the relative absorbing properties of the other tissues of the animal. Comparative data are given for rat liver sections and 25 other tissue activities calculated by this method and for those measured using Ba $^{14}CO_3$. Correction factors were calculated for samples of varying thickness from the extrapolates slope of the liver absorbance curve in relation to the curve for the particular tissue. Labelling was carried out by feeding adult male Wistar rats 18mg of DL-methionine-methyl-^{14}C, specific activity 4.5 mCi/mM. Absorption data were obtained from measurements of ^{14}C with a gas flow counter in freeze-dried sections of tissue. (UK)

49095 MECHANISMS OF HEPATIC UPTAKE OF HEPATOTROPIC RADIONUCLIDES. Trnovec, Tomas; Pleskova, Anna (Inst. of Industrial Health and Welfare, Bratislava). Prac. Lek.; 23: No. 5, 175-81(Jun 1971). (In Slovak).

The literature (103 references, mostly in English) on the retention of radionuclides by the liver is reviewed. The physicochemical state of the nuclides and of the blood are important in the deposition of these substances in the liver, as are the physiology and morphology of the liver cells and tissue and the bond of the radionuclides with the plasma proteins. Various concepts and theories that have been presented with regard to liver function in relation to radionuclides are discussed. (TTT)

49096 THOROTRAST QUANTITIES AND WHOLE-BODY COUNTS. Hemphill, F. M.; Hesselgren, R. D. (Environmental Health Service, Rockville, Md.). Health Phys.; 21: No. 1, 85-9 (Jul 1971).

Studies on which this paper was based investigated the significance of data from (a) quantity of Thorotrast administered, (b) years since Thorotrast administration, and (c) age of patient at time of Thorotrast administration, in estimating expected values of body burden. The aim was to seek practicable procedures of approximating body burden values without submitting patients to whole-body counting. From the data on 25 patients who had received Thorotrast 13 to 20 yr prior to whole-body counting, with an average age of 36.6 yr at the time of carotid artery injection, the following conclusions were drawn. Over ranges of the data studied, "age of patient at injection" and "years since injection" were found to be inconsequential for approximating body

burden scores. Statistically, the regression coefficient of neither variable is significant at the 5% level. "Quantity of Thorotrast injected" produces an apparently satisfactory estimate of body burden scores for assessments applicable to patient care to stratification of patients for research studies aimed at dose-effect determinations. The methods used are applicable to measurement data on variables, other than those considered in this study, that might be considered to improve estimates of expected values of body burden in Thorotrast patients. (auth)

49097 RADIO-CHLORIDE (^{36}Cl) AS A CONTINUOUS MONITOR OF ECW IN THE DOG. Swan, Henry; Nelson, A. Wendell; Hankes, Gerald H. (Colorado State Univ., Fort Collins). Ann. Surg.; 174: No. 2, 287-95(Aug 1971).

In nine splenectomized dogs, the plasma concentration of ^{36}Cl, the specific activity of plasma and lymph, and cumulative isotope urine loss were followed for 3 days. Equilibration in the solvent water compartment of the extracellular water was achieved at 10 minutes and the final chloride space at half-an-hour as evidenced by stabilization of specific activity in plasma and the ratio of specific activity in thoracic duct lymph to that in plasma achieving unity at that time. Use of a single injection to follow the chloride space continuously proved accurate for 48 hours. (auth)

Radiation Effects

Refer also to abstracts 48542, 49291, 49320, and 49327.

49098 (ANL-Trans-899) INVESTIGATING THE INTERACTION OF URANIUM WITH SEVERAL BIOCOMPLEXONS. Chevari, S.; Likhner, D. Translated for Argonne National Lab., Ill., from Med. Radiol.; 14: No. 7, 28-34(Jul 1969). 10p. Dep. NTIS.

This is an English translation of the Russian paper. An abstract of the original paper appeared previously in NSA Vol. 23: 38443. (E.R.B.)

49099 (UCLA-12-815, pp 1-36) RADIOBIOLOGY DIVISION. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology).

In Annual progress report June 30, 1971.

Progress is reported on the following: spectra and reactions of free radicals formed by pulse radiolysis of nucleic acids and related compounds; nanosecond pulse radiolysis of nucleic acid constituents; sites of attack by OH free radical on nucleotides and DNA; EPR studies on trapped species produced in the gamma radiolysis of aqueous sugar ices; free radical damage of nucleic acids and their components; pulse radiolysis studies on aqueous solutions of aminothiols and compounds related to nucleic acid; studies on the chemical basis of cellular radiosensitization by 5-bromouracil substitution in DNA; electron spin resonance studies of free radicals formed from orotic acid; ESR studies of free radicals in irradiated single crystals of 5-methylcytosine; the effect of chloride ions on the gamma radiation-induced destruction of DNA, nucleosides and nucleotides in aqueous solution; the effects of radiation modifiers on sugar-phosphate bond breakage in deoxynucleotides irradiated in aqueous solution; mechanism of radiation produced single strand break production in DNA; model systems for investigation of the mechanisms of single strand break productions in gamma irradiated nucleic acids; mechanism of the hydration effect of freeze-dried T1 bacteriophage; repair processes in bacteria; near-ultraviolet absorption bands of tryptophan: studies using indole and 3-methylindole as models; near-ultraviolet absorption bands of tryptophan: studies using horseradish peroxidase isoenzymes, bovine and horse heart cytochrome c, and N-stearyl-L-tryptophan n-hexyl ester; effect of temperature upon the conformations of carboxypeptidase A; use of circular dichroism to study the interactions of carboxypeptidase A (Anson) and $A_{\alpha+\beta}$ with substrates and inhibitors; regulation of enzymes in a differentiated rat glial cell line; influence of hormones on the outgrowth of neuronal processes in vitro; isolation and fractionation of RNA from the rat and the rooster; a comparison of RNA from different organs and cultured cells; ribonucleic acid metabolism in cell division; effect of synchronizing temperature shifts on the synthesis and translation of replication-supporting messengers in Tetrahymena pyriformis; effects of temperature shifts on nucleic acid metabolism; thermal bone marrow expansion; in vitro determination of radiosensitization; in vitro radioassay of chemosensitivity; and role of lysosomes in ischemic cell destruction. (H.L.W.)

49100 (USC-113-P-21-X-5) PROGRESS REPORT [ON ROLE OF MERCAPTO CONTAINING COMPOUNDS IN RADIATION DAMAGE], 1968-1971. (University of Southern California, Los Angeles). Contract AT(04-3)-113. 6p. Dep. NTIS.

The role of mercapto containing compounds in radiation damage and the possible mechanisms for the role of thiols as radioprotective agents are being investigated. Progress to date is reported in the broad areas of methodology and the chemical-biophysical aspects of the project. (E.R.B.)

49101 GAMMA IRRADIATION OF A DNA-Cu^{++} COMPLEX. Hofer, H.; Altmann, H. (Inst. of Biology, Seibersdorf, Austria). Int. J. Radiat. Biol.; 19: No. 5, 459-65(1971).

Cu^{++} in the DNA-Cu^{++} complex was reduced to Cu^{+} during irradiation. This Cu^{+} was responsible for the increased stability of the complex and for the changes in the absorption spectra. The effects of radiation on the complex were those on DNA alone and those produced by Cu^{+}. There was no difference in the radiation response of the DNA, as far as T_m values, absorption spectra, and binding places for Cu^{+} are concerned, whether Cu^{++} was complexed to DNA or not. (auth)

49102 DOSE DEPENDENCE OF THE TRANSFER OF RADIATION-INDUCED FREE RADICALS FROM DNA TO CYSTEAMINE. Milvy, Paul (New York Univ., N. Y.). Radiat. Res.; 47: No. 1, 83-93(Jul 1971).

ESR spectroscopy studies of the effect of the total absorbed dose in x-irradiated DNA-10% cysteamine samples were conducted. The samples were irradiated and ESR spectra were made in vacuo at 77°K. Additional spectra were obtained after heating the samples for 4 minutes at various temperatures to 373°K. In the range 2 to 0.2 Mrad, the number of organosulfur radicals observed in the annealed samples was a constant multiple of the yield of organosulfur radicals produced by the direct irradiation of the cysteamine component of the binary sample. In the 0.2 to 0.04-Mrad range, a substantial rise in this ratio was observed. At doses 0.04 and 0.02 Mrad, the same number of radicals were observed at 350°K as were initially present at 77°K, although they were, at this temperature, all organosulfur radicals. The recombination processes that prevent fully efficient radical migration occur in the 77 to 260°K temperature interval and these processes lead to a more pronounced reduction in the total number of radicals observed at 260°K in the high-dose runs than in the low-dose runs. In the temperature interval 260 to 350°K there is an increase in the number of radicals and this increase is the same in both high- and low-dose experiments. It was concluded that spin migration to the thiol is increasingly favored over spin recombination as the radiation dose (and, therefore, the radical density) is reduced. (auth)

49103 INFLUENCE OF THE MOLECULAR ORGANIZATION ON RADICAL YIELD OF ORGANIC COMPOUNDS. Checcucci, A.; Colombetti, G.; Columbu, A. M.; (and others) (CNR, Pisa, Italy). Radiat. Res.; 47: No. 1, 66-82(Jul 1971).

The dependence of radical yields on crystallographic properties in x-irradiated polycrystalline, aliphatic, straight-chain dicarboxylic acids was investigated by electron spin resonance. Both irradiation and recording of spectra were performed at 300 and 100°K. The analysis of ESR spectra shows that the same radical species are produced in all the acids both at room and low temperature. A correlation is found between packing coefficients and radical yields. A possible explanation of these results is discussed. (auth)

49104 RADIOLYSIS OF ALIPHATIC CARBOXYLIC ACIDS: THE DECARBOXYLATION OF NORMAL ACIDS AT 38°. Jones, A. Russell (Oak Ridge National Lab., Tenn.). Radiat. Res.; 47: No. 1, 35-40(Jul 1971).

The decarboxylation by gamma radiation of 23 members of the homologous series of straight-chain aliphatic carboxylic acids was studied at 38° in order to investigate the effects of molecular structure and phase on the radiolytic fragmentation of organic compounds. The carbon dioxide yields from the solid acids decrease in an essentially linear fashion as the chain length increases. This confirms a classic report on the alpha radiolysis of some of the homologs. However, the generally accepted notion that an adequate explanation for the decreasing yields is an increased efficiency of the back reaction between proposed alkyl and carboxyl free-radical intermediates brought about by the increased efficiency of caging that should accompany increased chain length is brought into question by the finding that the yields of carbon dioxide from the liquid acids are lower than those from the adjacent solid acids. Except for formic and acetic acids, the yields from the liquid homologs also decrease in an essentially linear fashion as the series is ascended, but the slopes for the liquid and solid phases are different. A reported difference in behavior of odd- and even-numbered acids in the liquid state was not confirmed. (auth)

49105 RBE AND THE PRIMARY MECHANISM OF RADIATION ACTION. Kellerer, Albrecht M.; Rossi, Harald H. (Columbia Univ., New York). Radiat. Res.; 47: No. 1, 15-34(Jul 1971).

The dependence of RBE on dose appears to follow a simple re-

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lation for a variety of effects on higher organisms and for a broad range of doses. The data indicate that the biological effects are due to primary lesions that may be produced by one or two high LET particles but require the action of at least two electrons when electromagnetic radiation is applied. The interaction distance exceeds 1 μm. (auth)

49106 CHANGES IN PHYSICO-CHEMICAL PROPERTIES OF POLYPHENOL OXIDASE AND ITS ISOZYMES IN γ-IRRADIATED VEGETABLE TISSUES. Kopylov, V. A.; Kuzin, A. M. (Inst. of Biological Physics, Pushchino, USSR). Dokl. Akad, Nauk SSSR; 196: No. 4, 965-8(1 Feb 1971). (In Russian).

It has been assumed that in γ-irradiated organisms, in addition to the direct inactivation of the ferment, its tertiary and quarternary structure may be inactivated, resulting in changes of the activity in the tissue. This problem was studied in the case of poiyphenoloxidase (PPO) at the level of its isozymes, irradiating Lorch type potato tubers with a ^{137}Cs source at a dose of 15 kR, and separating the ferment within 24 hours, making sure that the substrates were not oxidized. The highly active ferment was separated by dissolution, dialysis and salting out technique. The study revealed changes in the quantitative relations of the isozymes of the γ-irradiated ferments. The irradiation also caused broadening of the spectrum and changes in the activity, probably in the form of conformational changes of the molecules of the individual isozymes. Breakdown in the subsequent oxidation reactions lead to the accumulation of radiotoxins, such as quinones and oxyquinones. (TTT)

49107 γ IRRADIATION OF PURIC BASES IN AQUEOUS SOLUTION. COMPARATIVE DEGRADATION OF URIC ACID AND XANTHINE. Le Roux, Yvonne; Boulanger, Jean-Pierre; Arnaud, Robert (Centre de Recherches du Service de Sante des Armees, Lyon). Compt. Rend., Ser. C; 272: No. 21, 1757-60(24 May 1971). (In French).

The reactivity of uric acid in aqueous solution is more enhanced in the presence of ionizing radiations than xanthine; the two purines are more decomposed by irradiation in the presence of dissolved oxygen. Hydantoic acid was found to result from uric acid decomposition and 4-amino 5-formamido 2,6-dihydroxy pyrimidine from xanthine decomposition. A mechanism is proposed for the reactions. (auth)

49108 RADIORESISTANCE OF AFLATOXINS. Frank, H. K.; Grunewald, Th. (Federal Research Centre for Food Preservation, Karlsruhe, Ger.). Food Irradiat.; 11: No. 1-2, 15-20(Jul-Dec 1970). (In French).

Aflatoxin is produced by rice fermentation with Aspergillus flavus spores. Various samples of bread and rice containing aflatoxins were irradiated with 1 MeV electrons at a dose rate of 2.5 Mrad s^{-1}. The radioresistance of dried aflatoxins absorbed by silicagel is very high; the radioresistance is much less with aflatoxin solutions. But the doses necessary to destroy aflatoxin in food are so high that irradiation is not practical. (France)

49109 BIOCHEMICAL EFFECTS OF IRRADIATED SUGARS ON HUMAN CELLS IN CULTURE. Diaz-Santiago, Noemi. East Lansing, Mich.; Michigan State Univ. (1970). 84p. University Microfilms Order No. 71-18,183.

Thesis.

In the present study two criteria were used to test the toxicity of gamma-irradiated sugar solutions on human amnion AV_3 cells in culture: (a) the ability of the cells to grow and multiply after having been incubated with irradiated sucrose for various periods, and (b) the effect of irradiated glucose, fructose and sucrose on the synthesis of DNA, RNA, and protein in the same cells. Minimum essential medium (MEM) containing 5.8×10^{-2} M of 3 Mrad irradiated sucrose was incubated with AV_3 cells for 6, 12 and 24 hours at 37°C. After these periods the medium containing irradiated sucrose was replaced by medium containing non-irradiated sucrose and cell counts were made at 2, 4 and 6 days. The duration of the incubation of the cells with the irradiated sugar was critical for their growth and replication. The percentage of growth inhibition for the incubation periods of 6, 12 and 24 hours were: 40, 60, and 90 respectively. Other factors such as the effect of pH, the activity of DNA polymerase, the presence of catalase in the medium containing 3 Mrad irradiated sucrose and the time elapsed between irradiation of the sugar solution and testing for its effects on the DNA synthesis in AV_3 cells were also investigated. A considerable reduction in the toxicity of irradiated glucose was observed by maintaining the pH of the MEM containing irradiated glucose medium at 7.2 during the incubation period with the cells. The activity of DNA polymerase from an AV_3 cells extract was assessed following polymer formation measured by the incorporation of a nucleotide labeled with ^3H into acid-insoluble material (presumably DNA). The enzyme was not affected by the presence of irradiated sucrose in the substrate. It was also observed that a concentration of 40 μg/ml (66 units/ml) of catalase only partly eliminated the deleterious effects of 3 Mrad irradiated sucrose to human amnion cells. Sucrose solutions irradiated at 3 and 4 Mrad and stored for seven months at room temperature did not show a reduction on the inhibitory effects of the synthesis of DNA in AV_3 cells. Evidence was presented to show that the damage caused to human amnion cells by the radiolysis products of sucrose and fructose cannot be repaired. The duration of the incubation of the cells with the irradiated sugar, the radiation dose applied, the pH of the medium and the stage of development of the cells are critical for their survival. It seemed that only the fraction of the cell population specifically involved in DNA synthesis (the S phase of development) was severely affected by the radiolysis products of the sugars. This effect is time dependent: the longer the incubation period the higher the number of cells rendered unable to grow and multiply. (Diss. Abstr.)

49110 PROLONGED ACTION OF SUCCINYLCHOLINE AT THE HEIGHT OF ACUTE RADIATION SICKNESS. Kudryavtsev, V. D.; Khmelevskii, Ya. M. (Inst. of Medical Radiology, Obninsk, USSR). Vestn. Akad. Med. Nauk SSSR; 25: 84-90(1970). (In Russian).

Myoparalytic action of succinylcholine injected intravenously in five equal doses was studied in tests conducted on rabbits at the height of acute radiation sickness (10 to 11th day after gamma irradiation in doses of 800 and 1000 R). The EMG of the gastrocnemius muscle in response to electric stimulation of the sciatic nerve was registered under hexobarbital anesthesia and artificial ventilation of the lungs. An analysis of the periods and electrophysiological signs of the neuro-muscular block disclosed the presence of a prolonged succinylcholine action in irradiated animals, namely lengthening of the time needed for restoration of the neuro-muscular transmission of excitation. Possible mechanisms responsible for the prolongation of the muscular relaxation at the height of acute radiation sickness are discussed. (auth)

49111 FRAGMENTATION OF A STORAGE PROTEIN, ARACHIN, BY GAMMA RADIATION. Van Huystee, R. B. (Univ. of Western Ontario, London, Can.). Radiat. Bot.; 11: No. 4, 287-92(Jul 1971).

Aleurone grains were extracted from peanut cotyledons and purified on a sucrose density gradient. The protein isolated from this organelle appeared to be of a single macromolecular weight. Its purity was tested by gel filtration and disc electrophoresis. Exposure to 0.5 and 1 Mrad of this isolated buffer-suspended protein resulted in a breakdown of the molecules as was demonstrated by their multiple elution peaks on Sephadex G25 following exposure. The amount of small molecular fragments formed increased with a higher dose. The proteolytic activity was greatly suppressed following irradiation. (auth)

49112 BIOCHEMICAL, GENETIC, AND RADIATION STUDIES ON THE ESCHERICHIA COLI MINICELL. Fralick, Joe Andrew. Knoxville, Tenn.; Univ. of Tennessee (1970). 176p. University Microfilms Order No. 71-17,734.

Thesis.

Cells of a mutant strain of E. coli K-12 frequently undergo an abnormal cell division and produce small anucleate structures called minicells. Although minicells lack DNA they can acquire this macromolecule through such processes as bacterial conjugation and phage infection. Minicells acquiring DNA through phage infection or bacterial conjugation are incapable of supporting protein synthesis. Chemical analysis has shown minicells to be deficient in DNA-dependent RNA polymerase. The lack of protein synthesis, then, could be explained on this basis. To explore the possibility that the remainder of the minicells' protein synthesizing system is functional, the DNA-dependent step was bypassed and the capacity of a synthetic messenger RNA to promote polypeptide synthesis in minicell cell-free extracts was investigated. The results show that the minicell extract is capable of utilizing a polyuridylic acid message for the synthesis of poly-phenylalanine at a level comparable to normal E. coli cell extracts. This finding supports the idea that it is the absence of DNA-dependent RNA polymerase that prevents protein synthesis in intact minicells. Hybridization studies on DNA strands isolated from minicells mated with Hfr strains that transfer the proC region of the bacterial chromosome near their origin but in opposite directions suggest that the transferred DNA represents a unique strand. These findings also suggest a method for the isolation and purification of specific regions of the E. coli chromosome. Newly acquired, single-stranded DNA obtained from minicells mated to either Hfr or F^+ donors is predominantly membrane associated. Radiation studies on intact minicells showed that large exposures of ionizing radiation, when administered prior to conjugation, did not detectably alter the capacity of subsequently transferred DNA from becoming membrane associated, although it did appear to

interfere with the minicells' ability to take part in the process of bacterial conjugation. The relative insensitivity of the DNA-membrane attachment to ionizing radiation could be explained by the existence of multiple pre-existing DNA-binding sites. Such an explanation was supported by the demonstration that a dose of radiation that produced several breaks in the transferred DNA, decreasing its molecular weight by a factor of six, did not alter its degree of membrane association. This finding suggests that either the DNA is normally complexed with the membrane at more than one site or that radiation causes additional DNA-membrane associations. (Diss. Abstr. Int., B)

49113 POST-IRRADIATION INACTIVATION OF HORSERADISH PEROXIDASE. Macris, B. J.; Markakis, P. (Michigan State Univ., East Lansing). J. Food Sci.; 36: No. 5, 812-15(Jul-Aug 1971).

Aqueous solutions of purified horseradish peroxidase lost enzymic activity not only during irradiation with gamma rays, but also after irradiation. The higher the dose of irradiation, the greater the rate of post-irradiation inactivation. Enzyme activity loss after irradiation increased at higher temperatures of post-irradiation storage. Adjusting the pH of the irradiated enzyme solution to 9 resulted in greater inactivation than adjusting to pH 5 or 7. When the enzyme solution was diluted before irradiation, the inactivation proceeded more rapidly after irradiation than in the more concentrated solution. When, however, the already irradiated enzyme was diluted, it was the concentrated enzyme solution that lost more activity. Glycerol added to irradiated enzyme diminished the rate of inactivation. Irradiating a frozen enzyme solution resulted in very little or no loss of activity during post-irradiation storage. Neither irradiated water nor irradiated enzyme solution affected the activity of non-irradiated enzyme mixed with them. The following mechanism for the post-irradiation inactivation of HRPO is proposed: A portion of the enzyme that is not inactivated during irradiation is modified so as to result in subsequent inactivation by reacting with itself. (auth)

49114 ROLE OF PYRIMIDINE DIMERS IN THE INHIBITION OF DNA SYNTHESIS IN MAMMALIAN CELLS AFTER ULTRAVIOLET IRRADIATION: THE MATHEMATICAL INTERPRETATION OF RESULTS. Klimek, Miros; Vanicek, Jiri (Inst. of Biophysics, Brno). Math. Biosci.; 9: 165-77(1970).

The possibility of explaining the observed decline in successive recovery of DNA synthesis after bypassing of a block in the primer (represented by the pyrimidine dimer) was studied. This bypassing could be achieved by the random addition of bases in the section of the newly synthesized DNA that is opposite to the dimer obstacle, as well as by the so-called skipping mechanism. (This means that the DNA polymerase would continue to synthesize the DNA behind the dimer obstacle in the primer and that it would leave a discontinuity in the newly synthesized DNA. In a new molecule these gaps would be removed by the enzymatic junction of individual segments.) The results presented show that the DNA synthesis computed for mammalian L cells (on the basis of data about the yield of the pyrimidine dimers induction in the DNA of these cells after individual low doses of uv radiation) comes close to the synthesis measured in these cells. This finding (which results from the confrontation of the theoretical and experimentally measured values of DNA synthesis in L cells irradiated by uv radiation) suggests that pyrimidine dimers play a very important and maybe even decisive role in the inhibition and recovery of DNA synthesis in mammalian L cells irradiated by uv radiation. (auth)

Immunology

Refer also to abstract 49213.

49115 ANTIBODY FORMATION BY BONE MARROW CELLS IN IRRADIATED MICE. I. THYMUS-DEPENDENT AND THYMUS-INDEPENDENT RESPONSES TO SHEEP ERYTHROCYTES. Playfair, J. H. L.; Purves, Elizabeth C. (Middlesex Hospital Medical School, London). Immunology; 21: No. 1, 113-21(Jul 1971).

Bone marrow-thymus cooperation experiments were carried out in lethally irradiated mice with sheep red blood cells (SRBC) as the antigen and direct plaque-forming cells (PFC) as the end point. Various parameters were altered, with the following results: (1) Above 800 rad, the response by marrow cells alone, as well as the increase due to added thymus cells, was independent of irradiation dose. (2) The response of marrow cells was greatest at high SRBC concentrations, but the co-operative effect of thymus cells was most evident at lower SRBC levels, and completely absent at high levels. (3) Increasing the number of marrow cells, without thymus, gave increasing numbers of PFC, but the dose-response curve did not suggest cell synergism. (4) Thymectomy and antithymocyte serum treatment of host or donor did not prevent the response by marrow cells alone. It was concluded that this was a true IgM response by antibody-forming precursors from the marrow, unaided by thymus-derived cells. (auth)

Ecology

Refer also to abstracts 48612, 48616, 48666, 48675, 49075, 49076, 49080, 49087, 49171, 49195, and 51012.

49116 (BMI-171-138) AMCHITKA BIOENVIRONMENTAL PROGRAM: SIMULATION STUDIES AS RELATED TO THE ECOLOGICAL EFFECTS OF UNDERGROUND TESTING OF NUCLEAR DEVICES ON AMCHITKA ISLAND. Annual Progress Report, July 1, 1969-June 30, 1970. Bloom, S. G.; Raines, G. E. (Battelle Columbus Labs., Ohio). Jul 1971. Contract AT(26-1)-171. 22p. Dep. NTIS.

The FY 70 effort of the simulation studies was directed toward predicting the transport of radionuclides in the marine environment. Two models were used in series to identify the most important radionuclides and other factors affecting the calculation of potential internal radiation doses to man. These models, the specific-activity model and the marine-transport model, were developed during FY 68 and 69. Three computer programs were developed to compute the internal radiation doses on the basis of the two models. Two of these programs compute infinite-time doses for the two respective models while the third computes time-varying doses and radionuclide concentrations. The infinite-time programs were used to compute factors for converting initial specific activities or initial terrestrial radionuclide concentrations to infinite-time internal radiation doses. Only calculations for tritium were performed with the time-varying model. Source-term estimates for a MILROW type device were provided by the device-environment interface studies and these estimates were combined with the infinite-time dose factors to give conservatively high estimates of internal radiation doses from each radionuclide. The source term included estimates of fission products and rock-activation products but, in the absence of necessary input data, it was impossible to provide estimates of device-activation products or residual fissionable materials. Internal radiation doses were first computed from the specific-activity model. Of 101 radionuclides for which both health-physics data and source-term predictions were available, 54 could be eliminated from consideration as internal dose hazards because the total dose from all these nuclides, calculated on the basis of the intake starting at 30 days after the detonation and continuing forever, was 0.896 rem. The marine-transport model was then applied to the remaining 47 radionuclides, and internal radiation doses were calculated on the assumption that the intake of contaminated fish started 30 days after the detonation and continued forever. The sum of these doses was only 0.201 rem. The total internal radiation dose, as computed by these conservative calculations, was only 1.1 rem. Separate, time-varying dose estimates were also made for tritium using an unclassified source-term estimate. The maximum annual dose estimated for tritium occurred during the first year and was 9.5×10^{-8} rem. On the basis of all these calculations (which do not include the dose contributions from the device-activation products or residual fissionable materials), it can be assumed that underground nuclear detonations with this particular type of device and assumed hypothetical release of radionuclides (through venting) could not result in any significant internal radiation hazard to man. (auth)

49117 (CONF-710501-33) VARIATIONS OF ^{54}Mn, ^{60}Co, ^{65}Zn, ^{110m}Ag, AND ^{108m}Ag OBSERVED IN TUNAS. Folsom, T. R.; Young, D. R.; Hodge, V. F.; Grismore, R. (Scripps Institution of Oceanography, La Jolla, Calif.). [1970]. 26p. Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

Populations of the albacore tuna, Thunnus alalunga, were harvested from the Pacific Ocean near San Diego and gamma ray analyses were made of the liver tissue for ^{108m}Ag, ^{110m}Ag, ^{60}Co, ^{54}Mn, and ^{65}Zn from 1960 to 1970. Analyses were also made of the yellowfin tuna, Neothunnus macropterus, during 1968. It was found that most of the nuclide concentrations in the livers of the albacore decreased with time at the same rates as those predicted by physical decay constants; however, ^{65}Zn persisted at about the same levels from 1965 to 1970. Contributions of the Columbia River and global fallout to the ^{65}Zn in the ocean are discussed. Analyses of albacore caught at different stations along the coast of California showed that ^{65}Zn concentrations were essentially the same, indicating that global fallout contributed to the ^{65}Zn in the ocean. A model is described for the transport of radionuclides by the California Current in the Pacific Ocean, and the role of reactor wastes from Hanford is discussed. (H.L.W.)

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49118 (COO-1496-109) ECOLOGY AND LIFE HISTORY OF A POPULATION OF SCELOPORUS OCCIDENTALIS LONGIPES BAIRD ON RAINIER MESA, NEVADA TEST SITE, NYE COUNTY, NEVADA. Tanner, Wilmer W.; Hopkin, James M. (Brigham Young Univ., Provo, Utah). Apr 1971. 96p. Dep. NTIS.

A detailed study was made of the physical and biotic environment of the western fence lizard, Sceloporus occidentalis longipes on Rainier Mesa. Data are presented concerning altitude, temperature, soil conditions, and climatic conditions. A survey was made of the plant and animal life of Rainier Mesa and species are listed. Studies on the home range, or area utilized during one year, indicated that the maximum was 1.67 acres for adult male lizards. Observations were made on body temperature in relation to environmental temperature, size of gonads, size and numbers of eggs produced, growth curves, population structure, and food habits. Tables and graphs are presented to show results. (H.L.W.)

49119 (NP-18965) BIBLIOGRAPHY ON THE EFFECTS OF TEMPERATURE IN THE AQUATIC ENVIRONMENT AND ADDENDUM. Contribution No. 326. Kennedy, V. S.; Mihursky, J. A. (Maryland Univ., Solomons. Natural Resources Inst.). May 1967. 122p.

The bibliography and addendum contain 1499 citations to the literature on temperature effects in the aquatic environment. A subject index and an index based on the animal phyla are included. (E.R.B.)

49120 (UCLA-12-815, pp 63-97) ENVIRONMENTAL RADIATION. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology).

In Annual progress report June 30, 1971.

Progress is reported on the following: a computer program to select random quadrats within a polygon of any shape or size; spurious thermoluminescence of soils; influence of temperature during the gamma irradiation period on the subsequent thermoluminescence of soils and LiF and CaF_2 dosimeters; influence of clinoptilolite on ^{90}Sr and ^{137}Cs uptake by bean and barley plants; decay characteristics of soil thermoluminescence; persistence of radionuclides in soil, plants, and small mammals in areas contaminated with radioactive fallout; ecological attributes of perennial plants in the northern Mojave desert; revegetation problems following nuclear testing activities at the Nevada test site; fixation and utilization of nitrogen in desert vegetation; radiation doses to vegetation from close-in fallout at Project Schooner; some interactions of Ca, Sr, and Ba in plants; effect of boron levels on two different plant species that grow in soils high in boron; leaf temperatures of desert perennials in summer months; cycling of stable Cs in a desert ecosystem; seed germination of some northern Mojave, southern Great Basin plant species; estimation of some aspects of nitrogen and phosphorus cycling in the northern Mojave and southern Great Basin deserts; the home ranges of some rodents in Rock Valley; comparison of some IBP population estimation methods for small mammals; respiratory metabolism and body water turnover rates of Perognathus formosus in its natural environment; food consumption by heteromyid rodents in Rock Valley; allelic frequencies in irradiated and nonirradiated populations of Uta stansburiana; radioinduced sterility in natural populations of lizards; ecological efficiency of consumer populations; demography of Uta stansburiana in southern Nevada; densities and age distributions of vertebrate populations in Rock Valley, Nevada; lizards and tree frogs in an irradiated tropical forest; partition behavior of manganese(III) between bis(2-ethylhexyl) hydrogen phosphate and aqueous perchloric, formic, and acetic acids; the rapid and carrier free isolation of indium from macroconcentration of silver by liquid-liquid extraction; the energy metabolism of four species of desert rodents in their natural environments; persistence of plutonium in soil, plants, and small mammals; effect of a chronic exposure to gamma radiation on the shrub Ephedra nevadensis in the northern Mojave desert; ecology of the Nevada Test Site; vascular plant inventory; chronic low-level gamma irradiation of a desert ecosystem for five years; and response of desert shrubs to water potential. (H.L.W.)

49121 (UCLA-12-829) INFLUENCE OF CLINOPTILOLITE ON ^{90}Sr AND ^{137}Cs UPTAKES BY PLANTS. Nishita, H.; Haug, R. M. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). Aug 1971. Contract AT(04-1)-Gen-12. 27p. Dep. NTIS.

An experiment was conducted to determine the effect of Clinoptilolite on the ^{90}Sr and ^{137}Cs contents of bean and barley plants grown in soils contaminated at the surface (experiment I). An experiment was also conducted to determine the release of ^{90}Sr and ^{137}Cs to clover plants upon continuous and prolonged cropping of a contaminated soil with and without clinoptilolite treatment (experiment II). In experiment I, clinoptilolite was found to decrease the average ^{90}Sr contents of plants. The percentage reduction of ^{90}Sr contents of the different parts of the bean plants ranged from 48 to 70, 54 to 77 and 44 to 77 percent in the leaves, stems and fruits, respectively, depending on the amount of clinoptilolite application and the kind of soil. The percentage reduction of ^{90}Sr in barley plants under various treatments ranged from 57 to 77 and 57 to 79 for the leaves and stems and the heads respectively. In experiment II, eight harvests of clover were obtained. The application of Ca-treated clinoptilolite was effective in reducing ^{90}Sr contents of the plants grown in the mineral soil used, but it had no effect in the organic soil. Depending on the harvest time, the average ^{90}Sr contents of the plants grown in the treated mineral soil were 59 to 69 percent less than that of the control plants. Clinoptilolite was effective in maintaining the reduced ^{90}Sr contents of the plants throughout the experimental period. The ^{137}Cs contents of the plants were not changed appreciably by the application of clinoptilolite. (auth)

49122 (UCRL-72925) RECENT MEASUREMENTS OF ^{137}Cs RESIDENCE TIME IN ALASKAN VEGETATION. Martin, John R.; Koranda, John J. (California Univ., Livermore. Lawrence Radiation Lab.). 5 May 1971. 25p. (CONF-710501-34). Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

Radionuclide concentrations in Alaskan plant species were measured in the period 1967 to 1970 when incoming fallout was a small fraction of the accumulated inventory present in the vegetation. Samples were collected in five geographic areas from the western Aleutians to the interior of Alaska. Radionuclide concentrations in 150 g aliquots of dried, ground and compressed samples were measured by scintillation gamma spectrometry. The residence half-time for ^{137}Cs in Cladonia sp. lichens was found to be approximately three years on Amchitka Island and in the coastal area near Anchorage, Alaska. In central Alaska near Fairbanks and in the mountains near Anchorage, the residence half-time for ^{137}Cs in lichens was found to be about 8 years. Evergreen vascular plants from these higher elevation sites had residence half-times of only 1 to 3 years. (auth)

49123 ENVIRONMENTAL PROBLEMS AND NUCLEAR CHEMICAL ENGINEERING. Lieberman, Joseph A.; Janis, James R. (Dept. of Health, Education, and Welfare, Washington, D. C.). Chem. Eng. Progr., Symp. Ser.; 66: No. 104, 142-7(1970).

Environmental problems and the necessity of correcting these problems are discussed. Air pollution control, solid wastes management, occupational safety, and health and water resource management are considered. (auth)

49124 CONTAMINATION OF SHRIMPS (LEANDER SERRATUS PEN) BY ^{137}Cs THROUGH THE ALIMENTARY CANAL. Lemee, J. C.; Ancellin, J.; Vilquin, A. (CEA, Cherbourg, France). Radioprotection; 6: No. 2, 133-42(1971). (In French).

Shrimps were fed on mussles contaminated with ^{137}Cs; a sharp increase in contamination was noticed after each meal followed by partial decontamination. Residual contamination was about 15% of the activity of the diet; a comparison between the effects due to contamination from the diet and those due to contamination from the environment showed that the environment was the more important factor. (France)

49125 DISTRIBUTION OF CESIUM, RUBIDIUM, AND POTASSIUM IN THE QUASI-MARINE ECOSYSTEM OF THE SALTON SEA. Young, David Ross. San Diego, Calif.; Univ. of California (1970). 234p. University Microfilms Order No. 71-17,678.

Thesis.

During 1967 a yearlong study was conducted on the distributions of the trace alkali metals cesium and rubidium, and of potassium, in the ecosystem of the Salton Sea. This quasimarine environment provided the opportunity to study the behavior of these intracellular alkalies in a much simpler system than generally is found in the ocean. The dense phytoplankton populations growing in this agricultural sink, in conjunction with the zooplankton composed of only a few major species, produced a rich benthic organic mat. This mat provided food for both the detrital-feeding mullet that had migrated from the Gulf of California, and for the abundant pile worm. The threadfin shad, a migrant from the Colorado River system, fed principally on zooplankton. The pile worm was the principal food item of the two marine teleosts, the sargo and the Gulf croaker. The orangemouth corvina fed principally on the croaker. (These three transplanted marine fishes had reproducing populations in the Salton Sea.) Two independent determinations of the concentration factors for cesium and potassium in muscle tissue of the Salton Sea teleosts were employed. These techniques were gamma-ray spectrometry for fallout ^{137}Cs and natural ^{40}K, and flame photometry for stable cesium and potassium, and for rubidium. The two methods yielded equilibrium concentration factors for cesium and potas-

sium that agreed, on the average, within 7% and 1% respectively. A deionized water leaching technique was developed to determine approximate concentrations of cesium and potassium (independent of the sediment fractions) in the principal food items of the teleosts. Also, elemental measurements of the three cations were made in specimens of the four marine teleosts and water from the Gulf of California, and in shad from Lake Mead. The results of these analyses indicated that there were no significant spatial or temporal changes in any of the water or biological concentrations measured in the Salton Sea that precluded the validity of yearlong averaging. There were no correlations with temperature changes. However, a comparison of the concentration factors in teleost specimens from the Salton Sea and the Gulf of California did imply that the potassium content of the water, rather than the cesium content, affected the concentration of cesium in the biota. Also, a striking correlation of cesium concentration in muscle tissue of the five Salton Sea teleosts with the estimated trophic level occupied was demonstrated. Average concentration factors (over water values) for cesium in mullet, shad, sargo and croaker, and corvina were about 50, 80, 150, and 300 respectively. The factors for rubidium and potassium averaged about 20. The increase of teleost muscle cesium with trophic level (an approximate doubling per step) was consistent with observed "increase ratios" (fish/food) for cesium and cesium/potassium values, and suggests that cesium concentrations in ocean fishes may represent a useful tool in investigating feeding relationships in marine food webs. (Diss. Abstr.)

49126 PONTOPOREIA AFFINIS (CRUSTACEA, AMPHIPODA) AS A MONITOR OF RADIOACTIVITY IN LAKE MICHIGAN. Kidd, Charles Clifton Sr. Ann Arbor, Mich.; Univ. of Michigan (1970). 81p. University Microfilms Order No. 71-15,197.

Thesis.

Present plans call for the building of seven nuclear power plants on the shores of Lake Michigan that will be in operation by 1975 generating approximately 13,000 megawatts (thermal). The liquid wastes discharged to Lake Michigan from these facilities will contain minute quantities of radioactive elements. Accumulation of these radionuclides by aquatic organisms may damage the organisms or pose a radiological health hazard to man. Surveys of the aquatic environment near a nuclear facility must involve sampling of such monitor organisms in order to indicate the extent of damage to the environment and the severity of any health hazard to man. There is a need, therefore, to identify organisms that can be used as monitors of radionuclides released to Lake Michigan. This investigation involves the evaluation of Pontoporeia affinis, a benthic amphipod native to Lake Michigan, as a monitor of radionuclides found in radioactive wastes. A review of published information on the ecology of P. affinis in Lake Michigan, and observations of recent sampling results revealed that the average standing crop of this benthic amphipod was approximately 13 g (wet weight) per m^2, and that P. affinis was well distributed in almost all areas of the Lake Michigan benthic community. P. affinis exposed to dilute solutions of radioactive wastes from nuclear facilities accumulated radioactive strontium, manganese and zinc. Chemical analysis of whole P. affinis and lake water by atomic absorption spectrophotometry revealed that naturally occurring concentration factors (based on wet weight) for strontium, manganese and zinc in P. affinis were 260, 5,840 and 3,540 respectively. Repeated exposure of P. affinis to low concentrations (10^{-4} μCi/ml) of manganese-54 and zinc-85 indicated that quasiequilibrium concentrations of these radionuclides were established in 10 days. Strontium-85 concentrations in P. affinis exposed 10^{-4} μCi/ml approached equilibrium values in 23 days. Variations within the limits normally encountered in the natural environment of temperature and pH did not significantly influence accumulation of radionuclides by P. affinis. The presence of natural sediments in the laboratory environments increased the rates of accumulation of manganese-54 and zinc-65 by P. affinis. Elimination of accumulated strontium-85, manganese-54 and zinc-65 by P. affinis was prolonged by the presence of radioactive sediment. It was observed that sterilization of natural sediments significantly reduced the accumulation of manganese-54 and zinc-65 by P. affinis. It was concluded that P. affinis was a suitable monitor organism for manganese-54 and zinc-65. Atomic absorption spectrophotometry was used to measure the concentrations of strontium, manganese, and zinc in the flesh of Leuciscus cephalus (chubs), fish which feed almost exclusively on P. affinis. The equilibrium concentration factor for zinc in L. cephalus was 546. If equilibrium concentration of zinc-65 was realized in L. cephalus in water containing 10^{-4} μCi/ml of zinc-65 a potential health hazard would exist for persons continuously consuming more than 4 g per day of contaminated fish flesh. Measurement of radioactivity in L. cephalus taken from an area near the Big Rock Nuclear Reactor revealed that present concentrations of radionuclides in L. cephalus were well below hazardous levels. (Diss. Abstr.)

49127 SYMPOSIUM ON AMCHITKA ISLAND BIOENVIRONMENTAL STUDIES, BLOOMINGTON, INDIANA, 26–27 AUGUST 1970. Bioscience; 21: No. 12, 599-711(15 Jun 1971). (CONF-700843).

Twenty-six articles are included; separate abstracts were prepared for each. (P.C.H.)

For abstracts of individual papers see: 48611, 48612, 48666, 48675, 49128–49148, and 49195.

49128 ATOMIC ENERGY COMMISSION'S INTEREST IN BIOENVIRONMENTAL RESEARCH. Davis, J. J. (Atomic Energy Commission, Las Vegas, Nev.). Bioscience; 21: No. 12, 600-2(15 Jun 1971).

From twenty-first annual AIBS meeting; Bloomington, Ind. (26 Aug 1970). See CONF-700843.

The scope of research and development activities of the Atomic Energy Commission is reviewed, with emphasis on the development of bioenvironmental research programs. It is pointed out that the Amchitka Island bioenvironmental studies represent only a small part of the bioenvironmental program. The main objectives of the Amchitka program are designed to: characterize the ecological features of the Island and surrounding waters; predict, document, and evaluate the effects of nuclear testing activities on the biota and the environment; and recommend measures for minimizing adverse effects of nuclear testing activities on the biota and the environment. (C.H.)

49129 BIOENVIRONMENTAL STUDIES AT AMCHITKA ISLAND, ALASKA. Kirkwood, James B. (Battelle Memorial Inst., Columbus, Ohio). Contract AT(26-1)-171. Bioscience; 21: No. 12, 602-6(15 Jun 1971).

From twenty-first annual AIBS meeting; Bloomington, Ind. (26 Aug 1970). See CONF-700843.

The organization of the Amchitka Island bioenvironmental research program is reviewed. Field and laboratory studies to predict, evaluate, and document the effects of underground nuclear explosions on the environment and biota of Amchitka Island were begun during the summer of 1967. The Milrow underground nuclear test, a calibration test, was conducted on October 2, 1969. All data collected will be used to predict the ecological effects of future tests. (C.H.)

49130 MARINE FISHERY RESOURCES IN THE VICINITY OF AMCHITKA ISLAND, ALASKA. Merrell, Theodore R. Jr. (National Marine Fisheries Service, Auke Bay, Alaska). Contract AT(26-1)-171. Bioscience; 21: No. 12, 610-14(15 Jun 1971).

From twenty-first annual AIBS meeting; Bloomington, Ind. (26 Aug 1970). See CONF-700843.

Commercial fishery resources in the Amchitka Island, Alaska, area are utilized by United States, Soviet, and Japanese fishermen. Data available in 1969 on the extent of the resources and the nature of the fisheries are reviewed as a basis for predicting the potential effects of nuclear testing on the resources. (C.H.)

49131 STUDIES OF POPULATIONS OF SEA URCHINS, STRONGYLOCENTROTUS SP., IN RELATION TO UNDERGROUND NUCLEAR TESTING AT AMCHITKA ISLAND, ALASKA. Barr, Louis (National Marine Fisheries Service, Auke Bay, Alaska). Contract AT(26-1)-171. Bioscience; 21: No. 12, 614-17(15 Jun 1971).

From twenty-first annual AIBS meeting; Bloomington, Ind. (26 Aug 1970). See CONF-700843.

The population of sea urchins (Strongylocentrotus sp.) was selected for intensive quantitative study as an indicator of effects of changes in the shallow marine environment resulting from the Milrow underground nuclear test. Pre-test and post-test observations of sea urchin populations indicated no significant immediate effects of the test on the marine environment or organisms. (C.H.)

49132 DYNAMICS OF THE TERRESTRIAL ECOSYSTEM VEGETATION OF AMCHITKA ISLAND, ALASKA. Amundsen, C. C.; Clebsch, E. E. C. (Univ. of Tennessee, Knoxville). Contract AT(26-1)-171. Bioscience; 21: No. 12, 619-23(15 Jun 1971).

From twenty-first annual AIBS meeting; Bloomington, Ind. (26 Aug 1970). See CONF-700843.

Amchitka Island, Alaska, supports a terrestrial maritime tundra ecosystem. The isolation of the island, the maritime environment, and the low solar-energy input lead to a rather uniform vegetation with few important vascular species. Detailed studies were made on 10 plant community types within three topoenvironmental units between September 1967 and July 1970. The effects of shock waves from the Milrow nuclear test on plant communities have not been measured. (C.H.)

49133 DYNAMICS OF RAPTOR POPULATIONS ON AMCHITKA ISLAND, ALASKA. White, Clayton M. (Brigham Young

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Univ., Provo, Utah); Emison, William B.; Williamson, Francis S. L. Contract AT(26-1)-171. Bioscience; 21: No. 12, 623-7(15 Jun 1971).

From twenty-first annual AIBS meeting; Bloomington, Ind. (26 Aug 1970). See CONF-700843.

The dynamics of populations of bald eagles (Haliaeetus leucocephalus) and peregrine falcons (Faco peregrinus) on Amchitka Island, Alaska, during 1968 through 1970 were studied. The Milrow nuclear test caused no direct damage to the raptor population. (C.H.)

49134 GEOGRAPHICAL AFFINITIES AND MIGRATIONS OF THE AVIFAUNA ON AMCHITKA ISLAND, ALASKA. Emison, W. B. (Smithsonian Institution, Edgewater, Md.); Williamson, F. S. L.; White, C. M. Contract AT(26-1)-171. Bioscience; 21: No. 12, 627-31(15 Jun 1971).

From twenty-first annual AIBS meeting; Bloomington, Ind. (26 Aug 1970). See CONF-700843.

The breeding distributions, geographical affinities, and migration patterns of 52 species of birds found regularly on or near Amchitka Island, Alaska, were studied. The breeding distributions of 48 species that are found accidentally or casually on or near Amchitka were also studied. The seasonal occurrence of some species, with widely disjunct wintering and breeding areas, is indicative of the mobility and adaptability of the birds. (C.H.)

49135 CHANGES IN THE ECOLOGY OF THE PLANKTON COMMUNITIES ON AMCHITKA ISLAND, ALASKA. Koob, Derry D. (Ohio State Univ., Columbus). Contract AT(26-1)-171. Bioscience; 21: No. 12, 631-6(15 Jun 1971).

From twenty-first annual AIBS meeting; Bloomington, Ind. (26 Aug 1970). See CONF-700843.

A limnological study of the lakes and ponds on Amchitka Island, Alaska, was conducted during the summer of 1967 to obtain baseline data for evaluating the effects of Milrow nuclear test. Over 100 lakes and ponds were examined and 16 were selected for intensive event-related investigation. Data are presented from a series of studies on 11 lakes and ponds made during the spring of 1970, six to seven months following the Milrow detonation. No drastic changes in phytoplankton community structure were observed, although some shifts in the content of various chemical ions and measurable changes in metabolic parameters were found. (C.H.)

49136 FRESHWATER FOOD HABITS OF SALVELINUS MALMA (WALBAUM) ON AMCHITKA ISLAND, ALASKA. Palmisano, John J. (Univ. of Washington, Seattle); Helm, William T. Contract AT(26-1)-171. Bioscience; 21: No. 12, 637-41(15 Jun 1971).

From twenty-first annual AIBS meeting; Bloomington, Ind. (26 Aug 1970). See CONF-700843.

A survey was made of the food habits of a freshwater fish Salvelinus malma (walbaum) (Dolly Varden) collected from lakes and streams on Amchitka Island, Alaska, from December 1967 to November 1968. (C.H.)

49137 ECOLOGY OF THREESPINE STICKLEBACK GASTEROSTEUS ACULEATUS LINNAEUS ON AMCHITKA ISLAND, ALASKA. Valdez, Richard A.; Helm, William T. (Utah State Univ., Logan). Contract AT(26-1)-171. Bioscience; 21: No. 12, 641-5(15 Jun 1971).

From twenty-first annual AIBS meeting; Bloomington, Ind. (26 Aug 1970). See CONF-700843.

A study was made of the food habits of a freshwater fish Gasterosteus aculeatus (threespine stickleback) collected from lakes and streams on Amchitka Island, Alaska, during the last half of 1968. (C.H.)

49138 COASTAL ZOOPLANKTON AROUND AMCHITKA ISLAND, ALASKA. Mathisen, Ole A.; Peck, M. A. M. (Univ. of Washington, Seattle). Contract AT(26-1)-171. Bioscience; 21: No. 12, 652-5(15 Jun 1971).

From twenty-first annual AIBS meeting; Bloomington, Ind. (26 Aug 1970). See CONF-700843.

Results are reported from a study of marine zooplankton communities of the continental shelf of Amchitka Island, Alaska during 1967. Data on species composition, estimates of biomass of inshore zooplankton for each area-depth, and some data on the calanoid copepods are included. All animal organisms retained by a net with a mesh aperture of 0.33 mm were defined as zooplankton for purposes of the study. (C.H.)

49139 SPATIAL AND SEASONAL DISTRIBUTIONS OF MARINE ALGAL COMMUNITIES AT AMCHITKA ISLAND, ALASKA. Lebednik, P. A.; Weinmann, F. C.; Norris, R. E. (Univ. of Washington, Seattle). Contract AT(26-1)-171. Bioscience; 21: No. 12, 656-60(15 Jun 1971).

From twenty-first annual AIBS meeting; Bloomington, Ind. (26 Aug 1970). See CONF-700843.

Studies on the benthic marine algae of Amchitka Island, Alaska, were conducted during 1968, 1969, and 1970. The effects of terrestrial climate, sea temperature, wave action, and vertical zonation on the distribution of the more abundant species (Prasiola, Rhodochorton, Porphyra, Fucus, Hedophyllum, Alaria, Halosaccion, and Laminaria) were studied. (C.H.)

49140 TRANSECT STUDIES OF LITTORAL MACROFAUNA, AMCHITKA ISLAND, ALASKA. O'Clair, C. E.; Chew, K. K. (Univ. of Washington, Seattle). Contract AT(26-1)-171. Bioscience; 21: No. 12, 661-5(15 Jun 1971).

From twenty-first annual AIBS meeting; Bloomington, Ind. (26 Aug 1970). See CONF-700843.

Studies on the ecology of littoral invertebrate communities of Amchitka Island, Alaska, were begun in 1968 to assess the effects of physical disturbances resulting from underground nuclear explosions. The primary factors affecting invertebrate zonation on Amchitka are the tides and the topography of littoral rocks beaches. The vertical distribution and relative abundance of 20 invertebrate species, representative of the 95 species identified on Amchitka, were studied. The major groups studied were polychaetes (annelida), mollusks, crustaceans, and echinoderms. (C.H.)

49141 FISH COMMUNITIES AND FOOD CHAINS IN THE AMCHITKA AREA. Isakson, J. S.; Simenstad, C. A.; Burgner, R. L. (Univ. of Washington, Seattle). Contract AT(26-1)-171. Bioscience; 21: No. 12, 666-70(15 Jun 1971).

From twenty-first annual AIBS meeting; Bloomington, Ind. (26 Aug 1970). See CONF-700843.

A study of marine fish communities and food chains in the Amchitka Island area of Alaska was begun in 1967. Sampling methods used are described. Seventy-seven adult fish species were identified. Fish of either numerical, commercial, or ecological importance were selected for studies on their distribution, community relations, and food chains. A list of fish species captured during 1968, 1969, and 1970, identified by scientific and common names, is included. (C.H.)

49142 OBSERVATIONS ON THE EFFECT OF THE MILROW NUCLEAR TEST ON MARINE ORGANISMS AT AMCHITKA. Burgner, R. L.; Isakson, J. S.; Lebednik, P. A. (Battelle Memorial Inst., Columbus, Ohio. Univ. of Washington, Seattle). Contract AT(26-1)-171. Bioscience; 21: No. 12, 671-3(15 Jun 1971).

From twenty-first annual AIBS meeting; Bloomington, Ind. (26 Aug 1970). See CONF-700843.

Observations were made on the effects of physical disturbances resulting from the Milrow underground nuclear explosion on marine organisms at Amchitka Island, Alaska. Fish (Hemilepidotus hemilepidotuc and Hexagrammos lagocephalus) and crabs (Lithodes aequispina and Erimacrus isenbeckii) were placed in live boxes located from 3.2 km to 8.8 km offshore from Milrow. Examinations made about 4.5 hrs after Milrow showed the fish and crabs to be alive and apparently unharmed. (C.H.)

49143 SEA OTTER STUDIES IN THE VICINITY OF AMCHITKA ISLAND. Wright, Ronald A.; Allton, Wayne H. (Battelle Memorial Inst., Columbus, Ohio). Contract AT(26-1)-171. Bioscience; 21: No. 12, 673-7(15 Jun 1971).

From twenty-first annual AIBS meeting; Bloomington, Ind. (26 Aug 1970). See CONF-700843.

Activities of sea otters at Amchitka Island, Alaska, were documented before, during, and following the Milrow underground nuclear test on 60-mm film and videotape. Observations were also made on animals held in beach pens and floating pens, and on natural populations. It was concluded that Milrow had no effect on the sea otter population. (C.H.)

49144 BIOENVIRONMENTAL SURVEILLANCE EMPLOYING PHOTOGRAMMETRIC TECHNIQUES. Stephan, Joachim G. (Battelle Memorial Inst., Columbus, Ohio). Contract AT(26-1)-171. Bioscience; 21: No. 12, 677-82(15 Jun 1971).

From twenty-first annual AIBS meeting; Bloomington, Ind. (26 Aug 1970). See CONF-700843.

Aerial photography was used to survey the effects of the Milrow nuclear test on parameters that could have adverse effects on the ecology of Amchitka Island, Alaska. Some 30 rolls of infrared color film, five rolls of color film, and six rolls of black and white film exposed between September 9 and October 6, 1969 were analyzed. The method was satisfactory for determining the sea otter population, for documenting damage to cliffs and sea-stacks, the absence of damage to marine animal populations, and disturbances of lakes, streams, and vegetation in the vicinity of the test. (C.H.)

49145 LOWLAND STREAM ECOSYSTEM OF AMCHITKA ISLAND, ALASKA. Neuhold, John M. (Utah State Univ., Logan). Contract AT(26-1)-171. Bioscience; 21: No. 12, 683-6 (15 Jun 1971).

From twenty-first annual AIBS meeting; Bloomington, Ind. (26 Aug 1970). See CONF-700843.

The animal and plant ecology of Bridge Creek, Amchitka Island, Alaska, was documented to serve as a model of a lowland stream ecosystem. (C.H.)

49146 MATHEMATICAL SIMULATION OF SEA OTTER POPULATION DYNAMICS AMCHITKA ISLAND, ALASKA. Raines, G. E.; Bloom, S. G.; McKee, P. A.; Bell, J. C. (Battelle Memorial Inst., Columbus, Ohio). Contract AT(26-1)-171. Bioscience; 21: No. 12, 686-91(15 Jun 1971).

From twenty-first annual AIBS meeting; Bloomington, Ind. (26 Aug 1970). See CONF-700843.

A mathematical model of the dynamics of the population of sea otters at Amchitka Island, Alaska, was developed. The sea otter population in 1970 was estimated at 2000, with an average weight of 25 kg each, and food requirements of about 5 kg/day each. The model was applied in predictions of the population levels during the next 57 years. (C.H.)

49147 VARIATION IN THE TIMING OF BREEDING AND MOLT OF THE LAPLAND LONGSPUR (CALCARIUS LAPPONICUS) IN ALASKA, WITH RELATION TO DIFFERENCES IN LATITUDE. Williamson, F. S. L.; Emison, W. B. (Smithsonian Institution, Edgewater, Md.). Contract AT(26-1)-171. Bioscience; 21: No. 12, 701-7(15 Jun 1971).

From twenty-first annual AIBS meeting; Bloomington, Ind. (26 Aug 1970). See CONF-700843.

Comparisons are made between the breeding and molting habits of a bird, the Lapland longspur (Calcarius lapponicus), found at Amchitka Island and Cape Thompson, Alaska. The effects of differences in latitude on the behavior of the birds are discussed. (C.H.)

49148 SUMMARY OF ECOLOGICAL EFFECTS OF MILROW. Kirkwood, James B. (Battelle Memorial Inst., Columbus, Ohio). Contract AT(26-1)-171. Bioscience; 21: No. 12, 707-11(15 Jun 1971).

From twenty-first annual AIBS meeting; Bloomington, Ind. (26 Aug 1970). See CONF-700843.

Results are summarized from a number of studies on the effects of the Milrow underground nuclear test on the ecology of Amchitka Island, Alaska. It was concluded that an underground nuclear device of about one megaton yield can be detonated during the fall season at Amchitka without producing major damage of animal and plant populations or their environment, provided the radioactivity is contained underground. (C.H.)

49149 BOMB ^{14}C IN THE HUMAN POPULATION. Nydal, R.; Loevseth, K.; Syrstod, O. (Norwegian Inst. of Tech., Trondheim). Nature (London); 232: No. 5310, 418-21(6 Aug 1971).

A brief review is presented of studies on ^{14}C concentration in the human body, together with its distribution in the various regions of the atmosphere, the land biosphere, and the oceans. It is estimated that the amount of bomb-produced ^{14}C in the atmosphere has increased the total natural amount in nature by about 3%, but it has also been estimated that the production of CO_2 from fossil fuel would lower the natural ^{14}C concentration in the atmosphere to about 16% below normal by the end of the century; it is thus reasonable to assume that the ^{14}C excess caused by the bomb will be more than compensated by dilution with inactive C (the Suess effect). Factors on which transfer of ^{14}C into the human body depends are discussed. The authors studied this transfer by following the time variation of excess ^{14}C in blood and hair; there was excellent agreement between data obtained for both. Differences between the northern and southern hemispheres are considered. It is estimated that the excess ^{14}C in the human body has a mean lifetime of about 10 yr and that ^{14}C enters the body with a mean delay time of about 1.4 yr after production in the atmosphere. The hazard to the human population from artificial radiocarbon is also discussed. The authors are of the opinion that the only ^{14}C hazard from previous tests that should be taken into account is attributable to a total genetic dose of the order of 10 mR, received in a period of about 30 yr; this dose is negligible compared with the dose received from natural sources, which is about 100 mR per year. (UK)

Genetics and Cytogenetics

Refer also to abstracts 49194, 49270, 49271, 49284, 49301, 49315, 49320, and 49322.

49150 (COO-2001-3) GENETIC EFFECTS OF LOW X-RAY DOSES IN DROSOPHILA. Technical Progress Report, August 16, 1970–August 15, 1971. Abrahamson, Seymour; Meyer, Helen Unger (Wisconsin Univ., Madison). Contract AT(11-1)-2001. 9p. Dep. NTIS.

Preliminary results are reported from studies on the mutagenic effects of doses of 20, 100, or 500 R x radiation on oocytes and spermatocytes of immature Drosophila melanogaster. Breeding programs used to insure the reduction of spontaneous lethal mutations in the insect population are discussed. (C.H.)

49151 (NYO-1979-37) QUANTITATIVE POPULATION GENETICS OF MICE UNDER IRRADIATION. Final Report, October 1, 1956–December 31, 1970. Green, Earl L.; Roderick, Thomas H. (Jackson Lab., Bar Harbor, Maine). 28 Jan 1971. Contract AT(30-1)-1979. 19p. Dep. NTIS.

Populations of mice were propagated for 17 generations with spermatogonial irradiation. Mice were given 50 R per generation, 100 R per generation, or no irradiation (controls). The following characteristics were studied: frequency of non-productive matings, age of dam at time of litter, time between litters, number born, number weaned, number lost between birth and weaning, and gross phenotypic deviations. Those receiving 100 R showed a consistent reduction in litter size; there were no significant differences between the groups in other characteristics. Other experiments were conducted on the effects of radiation on genetic extinction, reproductive performance, embryonic mortality, longevity and body weight, recessive visibles, lethals, and heritability, inbreeding coefficients, inversions, repopulation of germinal epithelium, and fitness of heterozygotes. Research on genetics of radiation resistance included studies on inbred strains and crosses, selected lines, and germ cell renewal after irradiation. Other experiments were conducted on biochemical polymorphisms and mutations. (H.L.W.)

49152 (ORO-1747-17) RADIATION GENETICS AND RADIATION RESISTANCE IN PEANUTS. Progress Report, July 1, 1970–June 30, 1971. (North Carolina State Univ., Raleigh). Contract AT(40-1)-1747. 14p. Dep. NTIS.

The scope of the investigation is as follows: development of a mutation breeding model for self pollinated plants; the use of irradiation in the breeding cycle of self pollinated plants; and breeding value of the macromutant. The general objective is to improve the efficacy of mutation breeding procedures through the development of a large mutated base population of self pollinated plants, an effective means of encouraging recombination and the use of natural and/or artificial selection over generations. In 1969 approximately 1800 F_4 embryos were divided into two lots; one received 10 kR of x rays and the other served as control. The plants were harvested individually and the fruit maintained for further evaluation. The weight, length, and density of the fruit on each plant were determined and results are tabulated. It was concluded that the mutated backgrounds were randomly associated with the macromutant loci although decreased means were still noted in populations where the macromutant was part of the ancestry. (H.L.W.)

49153 (ORO-1747-18) RADIATION GENETICS AND RADIATION RESISTANCE IN PEANUTS. Progress Report, November 1, 1966–June 30, 1971. (North Carolina State Univ., Raleigh). Contract AT(40-1)-1747. 10p. Dep. NTIS.

Preliminary results are reported from a breeding program to increase the fruit size and yield of peanuts (Arachis hypogaea), in which exposure of the seed to γ or x radiation was used to induce mutations. To meet the demand of a large mutated (M_1) population with a broad genetic base, 65 natural outcrosses were produced (using recessive marker genes) between a bulk population representing eight high yielding commercial varieties or lines and a competitive hybrid-mutant resulting from re-irradiation. Approximately 900 F_4 embryos tracing to bulked outcrosses were irradiated in 1969 with 10 kR of x ray. The F_5 and F_5M_2 generations were increased in separate blocks in 1970. In 1971, two additional bulk populations were created by artificially selecting seed from fruit with lengths .75 to 1.25 standard deviations above the mean in each of the control and irradiated populations. As part of a larger investigation initiated in the early 1960's, three unique hybrid-irradiation populations were developed. These populations each included large numbers of F_2, F_2M_2 (irradiated with 20 kR γ radiation as F_1 embryos), and ($P1M_1 \times P2M_1$) F_2 embryos, respectively. Since the larger populations precluded evaluations of selection potential through the usual progeny test and variance component methods, it was decided to design a scheme where equal selection pressure for increased fruit yield could be applied systematically and uniformly in each population over several generations. The modified pedigree approach used is described. (C.H.)

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49154 (ORO-4241-1) PROGRESS REPORT ON AEC RESEARCH PROJECT, MAY 1970-MAY 1971. (Smithsonian Institution, Washington, D. C. Radiation Biology Lab.). Contract AT(30-1)-2373. 58p. Dep. NTIS.

The photoreactivation of uv-induced chromosome breaks in Tradescantia paludosa pollen tubes was studied using both far-red and red light. The combined effects of uv and far-red light on the rate of chromosome aberrations were also studied. The effects of temperature and nutrients on the growth of pollen tubes on culture slides were investigated. Data are presented on the number of chromosome aberrations in cells following treatment with various combinations of uv and red light. Data are included from studies on the sequence of amino acid synthesis in rye (Daucus carota) phytochrome made using cultured tissues grown under various conditions of light. Methods for physical measurements of solar radiation are discussed. The development of a radiometer for use in measurements of short wave solar radiation for a correlative study of the relation of daily and seasonal variations of spectral quality and intensity to plant responses is reported. (C.H.)

49155 EFFECTS OF RADIATION ON POPULATIONS OF DROSOPHILA MELANOGASTER WITH DIFFERENT GENETIC STRUCTURES. III. INTERACTION WITH POPULATION SIZE. Dyer, K. F. (Monash Univ., Clayton, Australia). Aust. J. Biol. Sci.; 24: No. 3, 585-91(Jun 1971).

A number of populations of D. melanogaster, varying in size from approximately 50 individuals to more than 5000, were chronically irradiated with 4000 R x-rays per generation and studied over a period of 40 generations to determine whether and to what extent the accumulation and equilibrium frequency of lethal chromosomes differed from one to the other. The overall fitness of these populations was studied by comparing the productivity of small samples taken from them, which were allowed to lay eggs and have their offspring develop under optimum conditions. Lethals accumulated more rapidly and to a greater extent in large populations. Productivity varied systematically with population size. Samples from the larger populations, despite having a higher frequency of lethals, consistently produced a greater number of offspring. Samples composed of males from one population and females from another were consistently less productive than the intrapopulation samples. The conclusions from these results, including estimates of the proportion of partially recessive, recessive, and overdominant lethals present in the populations, and the effects of integrated versus non-integrated gene pools are discussed. (auth)

49156 MUTAGENIC EFFECT OF UV-LIGHT AND X-RAYS ON STREPTOMYCES NIGRIFACIENS AND YIELD OF THE ANTIFUNGAL SUBSTANCE. Chaudhary, K. C. Basu; Gupta, S. (Banaras Hindu Univ., India. Agra Coll., India). Experientia; 27: No. 6, 706-7(15 Jun 1971).

Asporogenous and pigmented mutants of Streptomyces nigrifaciens were obtained following uv or x irradiation of single-spore suspensions of the fungus. Survival decreased with increasing doses in both cases. However, survival at all doses was much lower following x irradiation than was the case following uv irradiation. Assays for production of an antifungal substance by the two mutants selected showed an increase in production over that of the parent culture by the pigmented mutants and a decrease in production by the asporogenous mutants. (E.R.B.)

49157 OCCURRENCE OF GEOMETRICAL ISOMERS OF LYCOPENE IN THE MODIFICATION OF THE UV-INDUCED MUTANT OF MYCOBACTERIUM PHLEI. Hochmannova, J.; Kolmanova, A.; Malek, I. (Inst. of Microbiology, Prague). Folia Microbiol. (Prague); 16: No. 4, 293-8(1971).

During transfers of the uv-induced mutant of the non-acid-fast strain of Mycobacterium phlei (PN_3), its somewhat differently orange-red colored modification was found. The analysis of the cell pigment showed that unlike the PN_3 mutant which synthesizes the whole range of carotenes and xanthins, in the modification approximately half of the total amount of carotenoids is represented by chromatographically heterogeneous lycopene, the second half by γ-carotene. The further study of the lycopene fractions led to the conclusion that their difference is caused by the geometrical isomerism of the double bonds. The origin of the described cis-trans-isomers of lycopene is discussed. (auth)

49158 USE AND ABUSE OF CHROMOSOMAL ABERRATIONS AS AN INDICATOR OF GENETIC DAMAGE. Savage, John R. K. (Medical Research Council, Harwell, Eng.). Int. J. Environ. Stud.; 1: No. 3, 233-40(Mar 1971).

There are now many systems available for obtaining quick qualitative and quantitative assessments of chromosomal aberrations induced by various agents, and a number of these are being widely used as screening methods for possible genetic hazards. Qualitative studies are valid provided that observation is not confined to any one test system, and care is taken to ensure that aberrations observed are not the result of the experimental methods employed. However, the direct relationship of the gross structural changes that are observable, and the production of "heritable mutation" is not necessarily as clear as is often supposed. Very many quantitative studies are open to serious objection on the grounds that little or no thought has been given either to the time and mode of action of the compound under test in relation to the cell cycle, or to the profound perturbations which mutagens produce in the cell population. Often long treatments are given, and the same single fixation time (usually some hours after treatment) used for all "doses". In such experiments it is certain that the cellular populations are so changed by the time assessment is made that reliable estimates of aberration frequency cannot be obtained. These points are illustrated by reference to work with radiomimetic chemicals in plant cells, and some conclusions about experimental design for meaningful results drawn. (auth)

49159 FITNESS OF HETEROZYGOTES OF DELETERIOUS RECESSIVE MUTATIONS IN THE MOUSE. Green, Earl L. (Jackson Lab., Bar Harbor, Me.). Mutat. Res.; 12: No. 3, 281-9(Jul 1971).

The hair-deficiency mutation fs (furless) and the neurological mutation shm (shambling) are both recessive deleterious mutations of the mouse. They both depress the viability of homozygotes. Shambling mice weigh less and have shorter lives than their non-shambling littermates. Experimental attempts to detect effects of these mutations on the reproductive fitness of heterozygotes, fs/+ and shm/+, gave negative results. Also fs/+ mice were not more radiation-sensitive than +/+ mice. (auth)

49160 EFFECTS OF CHRONIC AND ACUTE IRRADIATION ON MORPHOLOGICAL CHARACTERS AND SEED YIELD IN FLAX. Bari, G. (London Univ. CNEN, Rome). Radiat. Bot.; 11: No. 4, 293-302(Jul 1971).

The effect of chronic irradiation was studied on flax plants subjected to exposure rates ranging from 100 R to 1000 R per 20-hr day throughout their life cycle in the ^{60}Co γ field. There was a significant increase in plant height at exposure rates from 400 R to 800 R/day, and in the number of primary branches at exposure rates from 300 R/day to 1000 R/day. The seed yield per plant at 100 R/day and 200 R/day was significantly higher than that of the non-irradiated plants, and this increase was due to an increase in the number of capsules per plant, although the number of seeds per capsule decreased constantly with increasing radiation exposures. Dry seeds of flax were subjected to ^{60}Co γ irradiation with exposures ranging from 10 kR to 250 kR, and the effects on morphological characters and yield performance were studied in the M_1 and M_2 generations along with the M_1 and M_2 generations of the chronically irradiated plants. There was a considerable increase of variability in morphological characters and seed yield in the progenies of both chronically and seed irradiated plants. A high yielding, yellow seeded mutant plant appeared in the M_2 progeny of a 600 R/day irradiated plant. About twice as much exposure of acute seed irradiation was found to produce similar damage at maturity as that produced by an accumulated exposure to chronic irradiation over the entire life cycle of the flax plants. (auth)

49161 GENETIC EFFECTS OF LIQUID HOLDING RECOVERY IN ULTRA VIOLET LIGHT SENSITIVE MUTANTS OF YEAST. Parry, James M. (University Coll., Swansea, Wales). Mol. Gen. Genet.; 111: No. 1, 51-60(18 Jun 1971).

The effect of liquid holding treatment after uv exposure has been determined in diploid yeast cultures carrying genes for uv sensitivity in both the homozygous and heterozygous condition. In all cultures liquid holding treatment produced increases in cell viability, but in cultures carrying a uvS gene this was not correlated with the increase in the frequency of intragenic recombinants characteristic of cultures wild type for uv sensitivity, but with a significant decrease in recombinant frequency. The data presented indicate that the reduction in recombinant frequency was not correlated with a reduction in the total number of recombinants after liquid holding treatment but was due to a selective increase in the frequency of non-recombinant cells. (auth)

49162 EFFECTS OF CAFFEINE ON THE INDUCTION OF MUTATIONS IN CHINESE HAMSTER CELLS BY ULTRAVIOLET LIGHT. Trosko, James E.; Chu, Ernest H. Y. (Michigan State Univ., East Lansing. Oak Ridge National Lab., Tenn.). Mutat. Res.; 12: No. 3, 337-40(Jul 1971).

Chinese hamster cells were inoculated into petri plates one day prior to uv irradiation. After irradiation, cells were collected and inoculated in medium with or without caffeine. Caffeine was pres-

ent in the medium for the entire post-irradiation period. The tabulated results show that uv irradiation increases the mutation frequency in mammalian cells and that caffeine lowers the frequency of mutations in irradiated as well as in unirradiated cultures. Possible interpretations of the results are discussed. (H.L.W.)

49163 ALLELISM TESTS OF MUTANTS AFFECTING SENSITIVITY TO RADIATION IN YEAST AND A PROPOSED NOMENCLATURE. Game, J. C.; Cox, B. S. (Botany School, Oxford). Mutat. Res.; 12: No. 3, 328-31(Jul 1971).

Workers who had isolated radiosensitive mutants of yeast agreed that all loci which mutate to affect the viability of yeast following irradiation should be designated rad followed by locus and allele numbers according to the convention agreed at the Osaka Yeast Genetics Conference in 1968. Allelism tests were performed by isolating single zygotes from the mating mixtures and testing the clones for uv sensitivity and ability to sporulate. A table is presented to show allelic relationships of radiosensitive mutants listed against the agreed interlab locus designations. Allelism tests were also carried out among x-ray sensitive mutants. (H.L.W.)

49164 INFLUENCE OF THE TEMPORAL DISTRIBUTION OF THE X-RAY DOSE ON THE INDUCTION OF X-CHROMOSOMAL NONDISJUNCTION AND X-CHROMOSOME LOSS IN OOCYTES OF DROSOPHILA MELANOGASTER. Traut, H. (Univ., Muenster, Ger.). Mutat. Res.: 12: No. 3, 321-7(Jul 1971).

The influence of dose fractionation and dose protraction on the induction of X-chromosomal nondisjunction and X-chromosome loss by x-rays in immature oocytes of Drosophila melanogaster has been investigated. In all experiments a dose of 1800 R was used. The dose rate was 850 R/min in the concentrated and fractionated treatments. As compared with the frequency obtained after a concentrated irradiation, the induction of nondisjunction was not influenced by dose fractionation (1-, 3- and 5-h intervals, respectively, between the halved dose). However, dose protraction (10 R/min) reduced the nondisjuction frequency highly significantly, and by a factor of about $\frac{1}{4}$. In the analogous experiments on X-chromosome loss ("true" losses, because losses resulting from nondisjunction were subtracted), both after dose fractionation and dose protraction the X-loss frequency decreased highly significantly, the reduction being more pronounced after protraction than after fractionation (under the special conditions of our experiments). The results are discussed in connection with the mechanism of radiation-induced nondisjunction and chromosome loss. (auth)

49165 RADIATION-INDUCED HUMAN CHROMOSOME ABERRATIONS: IN VITRO DOSE RATE STUDIES. Brewen, J. G.; Luippold, H. E. (Oak Ridge National Lab., Tenn.). Mutat. Res.: 305-14(Jul 1971).

Human whole blood samples were irradiated with a constant dose of either 250 kV x-rays or ^{137}Cs γ-rays for various periods of time. The yields of chromosome aberrations showed a striking dependence on the dose rate. Dose–response curves were constructed for acute (exposure time <4 min) x-rays and chronic (exposure time 24 h) γ-rays, and the data were fitted by least squares regression analysis to the models $Y = a + bD$, $Y = a + cD^2$, $Y = a + bD + cD^2$. In both instances the centric ring plus dicentric data gave the best fit to the quadratic model. The coefficients for the acute dose curve were $b = (0.91 \pm 0.2) \cdot 10^{-3}$ rings plus dicentrics/cell/R, and $c = (6.0 \pm 0.7) \cdot 10^{-6}$ rings plus dicentrics/cell/R^2. The coefficients for the chronic dose curve were $b = (0.68 \pm 0.1) \cdot 10^{-3}$ rings plus dicentrics/cell/R and $c = (0.68 \pm 0.23) \cdot 10^{-6}$ rings plus dicentrics/cell/R^2. The relative biological effectiveness of γ-rays, based on the linear component of the two dose curves, was 0.75. (auth)

49166 BIOCHEMICAL MEASURE OF THE TIME AND FREQUENCY OF RADIATION-INDUCED ALLELIC RECOMBINATION IN USTILAGO. Holliday, Robin (National Inst. for Medical Research, London). Nature (London) New Biol.; 232: No. 34, 233-6(25 Aug 1971).

Diploids with different mutations in the structural gene for nitrate reductase recombine to produce measurable enzyme activity. Gamma radiation induces recombination with high frequency, but only in cells that will survive the treatment. The results suggest that a recombination repair mechanism is induced in irradiated cells. (auth)

49167 PRODUCTION OF MUCOUS MUTANTS OF E. COLI K-12 AND STUDY OF THEIR PROPERTIES. Dombrovskii, A. M. (Moscow Medical Inst.). Zh. Mikrobiol., Epidemiol. Immunobiol.; 47: 82-6(Oct 1970). (In Russian).

In obtaining spheroplasts from various Escherichia coli K-12 strains and their reversion to the initial bacillary forms mutants with an excessive production of capsular polysaccharide, disturbed division of cells and formation of normal cell wall, were selected. It was found that various chemical substances and ultraviolet irradiation caused intensified production of capsular polysaccharide and formation of filamentous forms. (auth)

49168 CHROMOSOMAL MUTATIONS IN THE MAN DUE TO RADIATION. Szollar, Judit. Magy. Radiol.; 23: No. 3, 138-43(Jun 1971). (In Hungarian).

The most important problems in radiation genetics and the types of the mutations induced by radiation are discussed. The cytogenetic examinations performed in the population exposed to radiation are briefly reviewed. The importance of the chromosome examinations in persons subjected to prolonged exposures to radiation in consequence of their occupation, as well as in individuals who had suffered radiation lesions is stressed, this method being suitable for the measurement of the radiation injury and also of the dose producing the lesion. (auth)

Health Physics and Safety

Refer also to abstracts 49127 and 51153.

Radioactive Contamination and Decontamination

Refer also to abstracts 49092, 49116, 49117, 49120–49122, 49124, 49126, and 49308.

49169 PROTECTIVE ACTIONS FOR RADIOIODINE IN MILK. Bernhardt, David E.; Carter, Melvin W.; Buck, Francis N. (Public Health Service, Las Vegas, Nev.). Health Phys.; 21: No. 3, 401-16(Sep 1971).

The concept and history of protective action concerning radioiodine in milk, including planning prior to events and enactment after contaminating events is discussed. Of primary concern is the protective action taken by the Southwestern Radiological Health Laboratory (SWRHL) and the Atomic Energy Commission (AEC) in the Nevada Test Site offsite safety program. One of the best documented instances of protective action relates to the Pin Stripe Event in April 1966. This study indicated that about 70% of the total ^{131}I dose to a child's thyroid was prevented by changing the cows' ration from contaminated to uncontaminated forage at the time of peak ^{131}I milk concentration. This action by SWRHL in concurrence with the AEC was taken at levels below the Federal Radiation Council guides and, although intended primarily as a feasibility study, was a prudent measure for minimizing the potential thyroid dose. (auth)

Dosimetry and Monitoring

Refer also to abstracts 48461, 48840, 48841, 48903, 49018, 49020, 49021, 49105, 49168, 49281, 49283, 49319, 49957, 51121, and 51122.

49170 (AD-715017) BETA DOSIMETRY FOR FALLOUT HAZARD EVALUATION. Final Report. Brown, Stephen L.; Lane, William B.; Mackin, James L. (Stanford Research Inst., Menlo Park, Calif.). Jul 1970. Contract DAHC20-69-C-0297. 57p. NTIS.

A small beta dosimeter was developed for use in biological effects experiments. The dosimeter was calibrated and tested in a series of laboratory experiments, including a uniform volume source exposure, a point source exposure, surface roughness exposures, and an environmental resistance test. Dosimeters were then used in cooperation with biological experiments being conducted by other investigators, including a plant community exposure, a corn plot exposure, three wheat and potato exposures, and a field test of surface roughness. The measured data were then compared with calculated values and, in general, agreement was found to be satisfactory. (auth)

49171 (ANL-7760(Pt.3), pp 18-25) RADIONUCLIDE CONCENTRATIONS NEAR THE BIG ROCK POINT NUCLEAR POWER STATION. Nelson, Donald M.; Romberg, Gerald P.; Prepejchal, William (Argonne National Lab., Ill.).

In Radiological Physics Division annual report.

The radioactive effluent from the Big Rock reactor, which is mixed with cooling water and discharged into Lake Michigan through a shoreline channel, consists of a very low-level, continuous discharge plus periodic release of higher activity wastes. Samples of lake water collected at the discharge point before and during a release were analyzed for ^{134}Cs, ^{137}Cs, ^{60}Co, ^{65}Zn, and ^{95}Zr. The content of these five radioisotopes in crayfish, water snails, aquatic macrophytes, green algae, and fish collected near the discharge site was also measured. Results showed that several hundred grams (dry weight) of biological materials from

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the site would have to be consumed by man before the maximum permissible values for intake (as recommended in NBS Handbook 69) of these radioisotopes would be exceeded. (C.H.)

49172 (ARH-SA-87) DETERMINATION OF RADIATION DOSE TO PORTIONS OF THE BODY BY USING THERMOLUMINESCENT DOSIMETERS. Anderson, R. D.; Oscarson, E. E. (Atlantic Richfield Hanford Co., Richland, Wash.). 28 Jun 1971. 10p. (CONF-710719-7). Dep. NTIS.

From sixteenth annual health physics society meeting; New York, N. Y. (12 Jul 1971).

A two-part study was conducted using thermoluminescent dosimeters to compare the radiation dose of the chest with that of the wrists and gonads of employees engaged in obtaining radioactive process samples. The thermoluminescent dosimeters used were LiF chips, 1/8 inch by 1/8 inch by 0.035 inch. Because it would be necessary for the employee to wear the dosimeters for an eight-hour period each day for seven days, a plastic holder was designed to hold the dosimeters. The results of the study indicate that, under the conditions observed, the radiation dose to the gonads as compared to the chest is not sufficiently different to warrant a special interpretation of the chest-mounted personnel film badge dosimeter. The radiation dose to the wrist did not indicate a dose to the extremity which would be considered excessive as compared to the whole-body. Therefore, the whole-body dose can realistically be used as the controlling factor. The radiation doses received by all three locations (chest, wrist, and gonad) indicated that the employees received exposure from sources which were general in nature and no excessive exposure was received by any one location of the body. (C.H.)

49173 (CONF-710402-(Vol.2), pp II.7-15) FAST NEUTRON DEPTH DOSES AND SPECTRA OBTAINED BY BOMBARDING VARIOUS TARGETS WITH 16 MeV DEUTERONS. Parnell, C. J. (Hammersmith Hospital, London (England)).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

The fast neutron beam from the Medical Research Council's cyclotron at Hammersmith Hospital, London is produced by bombarding a beryllium target with 16.7 MeV deuterons. While the dose rate is typically 40 to 50 rad/min, the dose decreases to 50% at 7.5 to 10 cm depth in tissue. Thus tumors that can be treated satisfactorily are limited mainly to those of the breast, head and neck, and superficial sites. In an attempt to improve the depth dose characteristics, experiments were carried out using various thicknesses of beryllium and thick targets of other materials, i.e. heavy water, lithium, and carbon. Using a 10 cm × 10 cm field at a target-to-skin distance of 100 cm the greatest penetration was obtained with either heavy water or a thin beryllium target backed with gold, the thickness of the beryllium being about one quarter of the deuteron range. For thick targets of lithium, beryllium, and carbon the greatest penetration was obtained with carbon, but this was inferior to that obtained with heavy water or the optimum thin beryllium target. The fast neutron spectra obtained with some of these targets were examined with a recoil proton spectrometer. (auth)

49174 (CONF-710402-(Vol.2), pp II.16-21) EXPERIENCE IN TREATMENT DOSE CALCULATIONS FOR ^{252}Cf PATIENTS. Oliver, George D. Jr.; Wright, Peggy R.; Almond, Peter R. (Anderson (M. D.) Hospital and Tumor Inst., Houston, Tex.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

An experimental program, designed to evaluate ^{252}Cf versus conventional interstitial therapy, has been in progress in the Departments of Radiotherapy and Physics. Of significant importance in a treatment is the capability to calculate isodose distributions around the implant. A computer program was developed that produces complete neutron and gamma dose contours in selected planes through an implant. The program is based upon neutron transport theory calculations. Routinely, hand calculations are performed at selected points of medical pertinence as a check. Gamma dose calculations consistently show an average value of 75% of the neutron dose. Normally the calculated neutron physical dose rate times a selected RBE value of 7.5 is used, and the calculated gamma-ray physical dose times an RBE value of 1.0 is added to arrive at a biological dose rate in terms of rem/hr. Examples of patient dosimetry are presented. Utilization of this program for deep seated implant calculations yields more accurate numbers. Neutron doses to the patients' eye lens also were calculated; some lip and cheek implants were found to deliver excessive doses to the eye. (auth)

49175 (EUR-4330) CHRONIC INTERNAL DOSE CALCULATIONS FROM DIRECT OR INDIRECT PERIODIC MEASUREMENTS OF HUMAN INTERNAL RADIOACTIVITY. APPLICATION TO TRITIUM ANALYSIS. Guillot, P. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1969. 29p. (In French). NTIS (U. S. Sales Only).

The periodic measurements of the human internal radioactivity, by direct or indirect methods, should be expressed in doses, using some hypothesis about intake. Without further indication, the following hypothesis may be accepted: each time unit passed in a contaminated area, the professionally exposed people internal radioactivity increases by a constant amount. If the retention in the whole body is a linear function of the elapsed time during a 24 hr interval, it can be proved that the whole-body dose is a linear function of the internal radioactivity, according to the formula: $D = K_1A_1 + K_2A_2$ where A_1, A_2 = internal total radioactivity, measured on time t_1 and t_2, and K_1, K_2 = coefficients that depend on the radioisotope physical constants and metabolism, as well as the time interval $t_2 - t_1$. The maximum and minimum limits of the dose correspond to the instantaneous and unique intake hypothesis, either on time t_1 or t_2. These limits are: maximum dose – $D_M = C_2A_2$ and minimum dose – $D_m = C_1A_1$. The case of periodical tritium analysis in urine is considered as an example for calculation of C_1, C_2, K_1, and K_2 values. (auth)

49176 (JAERI-13524) RADIATION CONTROL. Quarterly Report, No. 20. (Japan Atomic Energy Research Inst., Tokai). Apr 1969. 38p. NTIS (U. S. Sales Only).

This quarterly (Jan. to Mar., 1969) report contains radiation monitoring data on the reactors and radioisotope handling facilities at Tokai Research Establishment. (auth)

49177 (JAERI-13687) QUARTERLY REPORT OF THE RADIATION CONTROL, NO. 21. Mori, K. (Japan Atomic Energy Research Inst., Tokai). Aug 1969. 38p. NTIS (U. S. Sales Only).

Records and other values of the radiation control in JAERI, for the period of April to June 1969, are given: Head office in Tokyo, Tokai Research Establishment and Oarai Research Establishment in Ibaraki prefecture, and Takasaki Radiation Chemistry Research Establishment in Gunna prefecture. The radiation controls carried out include the following: personnel control for both external and internal exposure; facilities control for radioactivities in dusts, exhaust gases, and drainage; environmental control in field monitoring and weather observation; wastes treatment for both JAERI and outside organizations, and decontamination; and significant contaminations and exposures. (auth)

49178 (UCRL-51069) RADIONUCLIDES IN SURFACE AIR AT LIVERMORE, CALIFORNIA. Hamby, Keith O. (California Univ., Livermore. Lawrence Radiation Lab.). 15 Jun 1971. Contract W-7405-eng-48. 6p. Dep. NTIS.

Analyses of three sets of air filters exposed in the fall and winter of 1970–1971 on the grounds of the Lawrence Radiation Laboratory, Livermore, California, show the presence of a number of radionuclides usually attributed to worldwide fallout. These include ^{95}Zr, ^{103}Ru, ^{106}Ru, ^{137}Cs, ^{141}Ce, ^{144}Ce, ^{125}Sb, and ^{155}Eu. Also observed was the cosmic-ray-induced ^{7}Be. Relatively large volumes of surface air were sampled over three different periods ranging from two to eight weeks in duration. Radioactive components of the samples were determined by gamma spectroscopy using Ge(Li) detectors. (auth)

49179 (UCRL-51093) SEMIANNUAL REPORT OF ENVIRONMENTAL LEVELS OF RADIOACTIVITY IN THE VICINITY OF THE LAWRENCE LIVERMORE LABORATORY, JANUARY THROUGH JUNE 1971. Gudiksen, P. H. (California Univ., Livermore. Lawrence Radiation Lab.). 12 Jul 1971. Contract W-7405-eng-48. 24p. Dep. NTIS.

An environmental surveillance program was conducted within the Livermore Valley and Site 300 areas to determine the effect of the Lawrence Livermore Laboratory operations on the surrounding environment. Analyses for gross radioactivity and for specific radionuclides of interest in a variety of environmental samples were performed. The results of these analyses are provided in the report. Air particulates, soil, water, and sewage samples showed similar gross radioactivities to those measured during the past year. Gamma spectral measurements of on-site airborne particulates revealed detectable activities of the typical gamma emitters observed in global fallout. Isotopic uranium analyses of particulates collected on air filters at Site 300 indicate the uranium in the particulates was depleted in ^{235}U with respect to that for natural uranium. Soil samples subjected to plutonium, strontium, and gamma spectral analyses showed no detectable buildup of these activities in the off-site environment. (auth)

49180 MEASUREMENT OF RADIOACTIVITY IN BODY ORGANS. REPORT OF AN INTERNATIONAL ATOMIC ENERGY AGENCY PANEL. Int. J. App.. Radiat. Isotop.; 22: No. 7, 385-98(Jul 1971).

This report was drawn up by a panel of nine experts convened by the International Atomic Energy Agency in December 1969 to discuss the techniques available for the measurement of radioactivity in body organs. The report provides a general review of the techniques available for such measurements and the main problems that they entail. It then deals, in turn, with measurement techniques based on the use of fixed detector systems, techniques based on whole-body radioactivity measurements, techniques based on the analysis of profile scanning data and techniques based on the analysis of scintigraphic data. The present status of each technique is reviewed, its particular advantages and disadvantages are indicated, and its main applications listed. Consideration is also given to the relative sensitivities of different techniques. (auth)

49181 DOUBTS ABOUT THE NOMINAL STANDARD DOSE. Probert, J. C. (Stanford Univ., Calif.). Brit. J. Radiol.; 44: No. 524, 648-9(Aug 1971).

Doubts are expressed as to the general application of the nominal standard dose (NSD) concept. Variations in results using $D = NSD \times N^{0.24} \times T^{0.11}$ could be due to the volume factor of the tumor and number of fractions. It is pointed out that the NSD concept is based on early reactions, but the most important normal tissue reactions are usually late. The equation is based almost entirely on the response of one sort of tissue (subcutaneous connective). Doubts are also expressed as to the equation $D = NSD \times N^{0.24}$ always being independent of time, regardless of how the doses are fractionated. (UK)

49182 DISTRIBUTION OF THE DOSE FROM NEUTRONS IN A THIN SAMPLE OF WET TISSUE AS A FUNCTION OF LINEAR ENERGY TRANSFER (LET_∞). Dousset, M. H.; Hamard, J.; Ricourt, A. (CEA, Fontenay-aux-Roses, France). Phys. Med. Biol.; 16: No. 3, 467–78(Jul 1971).

In order to contribute to the interpretation of radiobiological data obtained when thin samples of tissue are exposed to neutrons, the absorbed dose distribution as a function of LET_∞ was calculated for monoenergetic neutrons with energies between 0.025 eV and 10 MeV. From the results obtained, the dose distribution for neutrons with a complex energy spectrum may be easily calculated. (auth)

49183 RECOIL PROTON DOSE ACROSS A BONE-TISSUE INTERFACE DUE TO FAST NEUTRONS. Prasad, M. A.; Sundararaman, V.; Venkataraman, G. (Bhabha Atomic Research Centre, Trombay, India). Phys. Med. Biol.; 16: No. 3, 461-6 (Jul 1971).

The perturbation in the recoil proton dose in soft tissue under fast neutron irradiation, due to the presence of bone, was calculated for the particular case of a slab of tissue bounded by two parallel slabs of bone. The calculations took into account the actual angular distribution and angle-energy relationships of the recoil protons. Significant differences between the present calculations and those made earlier by Lawson (1967) on more simplified assumptions were observed. The calculations were extended to the case of cylindrical tissue cavities in bone. (auth)

49184 NEUTRON RADIOGRAPHY AND DOSIMETRY IN HUMAN BEINGS: THEORETICAL STUDIES. Budinger, T. F. (Univ. of California, Berkeley); Plechaty, E. F.; Howerton, R. J. Phys. Med. Biol.; 16: No. 3, 439-50(Jul 1971).

Calculations were done for neutrons of 1 KeV, 120 KeV, fission spectrum, and 14 MeV, incident on a simulated human arm, to analyse the dose distributed to bone and marrow, and to determine the feasibility of neutron radiography as a practical clinical tool. The resolution possible through tissues as thick as 6 cm makes neutron radiography impractical except for very special circumstances. The dose calculations reveal as much as a twofold increase in dose deposited in the bone cortex compared with surrounding contiguous tissues. The skin dose is approximately twice the dose 3 cm inside the tissue. The average absorbed dose in the arm on the basis of a fluence of 10^{10} neutrons incident per cm^2 is: 0.5, 1.6, 10, and 40.4 rads for 1 keV, 120 keV, fission spectrum, and 14 MeV neutrons, respectively. (auth)

49185 MEASUREMENT OF SKIN DOSE FROM LOW ENERGY BETA AND GAMMA RADIATION USING THERMOLUMINESCENT DISCS. Marshall, M.; Docherty, J. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Med. Biol.; 16: No. 3, 503-10(Jul 1971).

A thermoluminescent dosemeter is described, designed to measure the dose to the basal layer in mixed β- and γ-radiation fields. Very thin Teflon discs, 8.9 mg cm^{-2} thick and 1.27 cm diameter, loaded with LiF, provide a convenient measure of the β-ray dose. When covered by a polyethylene window of 3.7 mg cm^{-2} their response is equivalent to the dose under 7 mg cm^{-2} of tissue to within 10% for β-rays with maximum energies of 0.15 to 2.27 MeV. The response to x and γ rays above 80 KeV is independent of energy and similar to the β-ray response, but below 80 keV the sensitivity relative to β-rays increases to a maximum of 1.5 around 30 KeV. The dosemeter can be used in mixed $\beta-\gamma$ radiation fields and is particularly suited to the measurement of extremity doses. (auth)

49186 DOSE-DISTRIBUTION MEASUREMENT OF HIGH-INTENSITY PULSED RADIATION BY MEANS OF HOLOGRAPHIC INTERFEROMETRY. Hussmann, E. K.; McLaughlin, W. L. (National Bureau of Standards, Washington, D. C.). Radiat. Res.; 47: No. 1, 1-14(Jul 1971).

A novel calorimetric method was developed for absolute determination of the spatial distribution of radiation absorbed dose in transparent liquids, particularly for dosimetry of pulsed, high-intensity electron beams. Local temperature change is determined without the introduction of temperature sensors that may disturb the radiation field. The change in a liquid's refractive index, which is a function of temperature, is measured by an interferometric method employing holographic wavefront reconstruction. For radiation beams essentially symmetric to the direction of propagation, the three-dimensional dose distribution can be derived from the information given by the interferogram. Dose distributions in water were evaluated for short electron pulses of different energy spectra. (auth)

49187 COMMENT ON A NEW TECHNIQUE FOR REACTOR SITING DOSE CALCULATIONS. Skibbin, D. (Nuclear Research Centre, Negev, Israel). Health Phys.; 21: No. 1, 123-4(Jul 1971).

It is pointed out that the Gaussian representation of the concentration distribution of the released radioactivity used in the paper by Willis et al., Health Phys: 19, 47 (1970), may lead to errors, especially when cutting the zone of integration for direct γ dose computation. A suggestion is made for limiting these errors, which are largest for down wind regions. (UK)

49188 CRITICAL OBSERVATIONS ON RTL-DOSIMETRY. Regulla, D. (Gesellschaft fuer Strahlenforschung mbH, Munich). Stud. Biophys.; 26: No. 1, 31-40(1971). (In German).

If not allowed for, the described error sources of RTL dosimetry with LiF may lead to systematic measuring errors of several up to some 100 percent. Radiothermoluminescence is, therefore, suitable as a procedure of dose measurement only if there are corresponding error-reducing measurement regulations, the strict observation of which between calibration and measurement is guaranteed in every detail. By carefully minimizing all error sources, a reproducibility of the RTL yield/dose unit at standard deviations of 0.9 to 1.5 percent (exception: "teflon-rods") is possible for a tenfold use of a single measuring probe. (auth)

49189 FIRST RESULTS IN THE DETERMINATION OF DOSE DISTRIBUTION IN TANGENTIAL STATIONARY FIELDS WITH A DIGITAL COMPUTER. Heilmann, H.-P.; Schroeder, U. G. (Univ., Tuebingen, Ger.). Fortschr. Geb. Roentgenstr. Nuklearmed.; 114: No. 6, 839-43(Jun 1971). (In German).

The isodoses of tangential telecobalt stationary fields were plotted on the basis of ionometric dose measurements with wedge filters within the point matrix of a special plexiglas water phantom. A digital computer with a special interpolation program was used for this purpose. This procedure makes it possible to calculate the summation isodoses from opposing-beam angles or, as the case may be, field intervals on dose distribution. (auth)

49190 DOSE DISTRIBUTION IN RADIOTHERAPY. ESPECIALLY IN ITS RELATION TO OPTIMUM IRRADIATION METHOD. Kutsutani, Yuzuru (National Inst. of Radiological Sciences, Chiba, Japan). Hoshasen Kagaku; 13: No. 10, 9-14(Oct 1970). (In Japanese).

One of the features of present radiotherapy is employment of high-energy radiation. The high-energy radiation is superior for treating deep-seated lesions in the following respects: penetration to deep parts; homogeneous dose distribution in the beam; and less effect on skin and surrounding normal tissues due to reduced amount of scattered radiation. In order to obtain an ideal dose distribution in the treated region, two or three portal irradiation, with wedge filters if necessary, is performed. Recently, computers have been used for summing up the dose contribution from various portals, and now they are also used to obtain the optimum dose distribution. As necessary conditions for the optimum dose distribution, the author adopts the following criteria: the dose in the treated region by three portal irradiation with wedge filters is homogeneously distributed and is above 80% of the dose at the tumor center; the dose contribution from the three portals is equal (1 : 1 : 1); the integral dose is minimized; the tumor dose is high in comparison with the skin dose; and the dose to radiosensitive organs should not exceed the tolerance

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dose. Based on these five criteria, the optimum irradiation method is determined with the aid of a computer. Furthermore, the biological effect should be considered for determining the optimum irradiation method. For example, high LET radiation with Bragg peak should be utilized to obtain a higher dose at the tumor center, because more hypoxic cells exist there, and optimum fractionating conditions including split course technique should be sought, considering reoxygenation recovery, and repopulation of normal and tumor cells. (Japan)

49191 USE OF LiF-TEFLON DISCS IN LAMINATED IDENTIFICATION CARDS FOR PERSONNEL ACCIDENT DOSIMETRY. Nash, A. E.; Attix, F. H. Health Phys.; 21: No. 3, 435-9(Sep 1971).

The application of LiF-Teflon discs as accident dosimeters, laminated between the plastic layers of an identification card, is described. Pairs of ^{7}LiF and ^{6}LiF discs are employed to provide some neutron detection capability. The discs are each 6 mm in dia. and 0.13 mm thick, and the pair is wrapped in Al foil to avoid sticking to the lamination and generation of spurious TL signals. (auth)

49192 HUMAN RADIOACTIVITY COUNTER AND MEDICAL VAN. Howard, Leroy E. Jr.; Spickard, John H.; Wilhelmsen, Mack (Atomic Energy Commission, Idaho Falls, Idaho). Health Phys.; 21: No. 3, 417-20(Sep 1971).

A mobile Human Radioactivity Counter and Medical Van was designed to reduce the cost of whole-body counting and to increase general health surveillance at the National Reactor Testing Station by bringing laboratory facilities to the work areas. The van is scheduled at each of the main reactor areas on a routine basis, which eliminates the employee from having to travel up to 70 miles for monitoring checkups. The whole-body counter utilizes the minimal shielding concept as well as the rotational counting technique that permits the simultaneous quantification and localization of γ emitting nuclides from a single count. Calibration of the counter was accomplished by using human volunteers who had ingested single radionuclides. The detection limit for most γ emitting nuclides is well below the maximum permissible body burdens recommended by the ICRP. Over 5000 individuals have received whole-body analyses, laboratory, and x ray examinations since this van was put into operation. This mobile instrument has proven to be an effective and economical addition to the health services program. (auth)

49193 NOTES ON BUILDUP FACTORS AND UTILIZATION OF A POWER FUNCTION ANALYTICAL REPRESENTATION OF THE BUILDUP FACTOR. Chabot, G. E.; Skrable, K. W.; Wedlick, H. L. (Lowell Technological Inst., Mass.). Health Phys.; 21: No. 3, 471-3(Sep 1971).

Analytical expressions for the build-up factor of γ ray doses are discussed, and the use of a criterion for testing the validity of values of resulting parameters in energy deposition build-up factors are explained. Limitations of the formulae are noted. (UK)

49194 ESTIMATES OF THE GENETIC RISKS FROM IONIZING IRRADIATION. Luening, K. G.; Searle, A. G. (Lab. of Radiation Genetics, Stockholm. Medical Research Council, Harwell, Eng.). Mutat. Res.; 12: No. 3, 291-304(Jul 1971).

To make estimates of the hazards of ionizing irradiation we have reviewed various types of mutational event in mice. For comparisons of the different types of mutation we have calculated the acute dosages necessary to induce in spermatogonia as many mutations as occur spontaneously. Dominant lethals fall completely outside the usual range, indicating a very high doubling dose. For the other types of mutation the analysis showed an unexpected similarity (doubling dose in parentheses), namely semisterile mutations (31 R), specific-locus mutations (32 R), dominant visible mutations (16 R), dominant mutations affecting the skeleton (26 R) and recessive autosomal lethals (51 R). Hazards of chronic and fast neutron irradiation as well as irradiation of females are also considered in relation to these results. (auth)

49195 MATHEMATICAL MODELS FOR PREDICTING THE TRANSPORT OF RADIONUCLIDES IN A MARINE ENVIRONMENT. Bloom, S. G.; Raines, G. E. (Battelle Memorial Inst., Columbus, Ohio). Contract AT(26-1)-171. Bioscience; 21: No. 12, 691-6(15 Jun 1971).

From twenty-first annual AIBS meeting; Bloomington, Ind. (26 Aug 1970). See CONF-700843.

A mathematical model was developed for use in predicting the transport of fallout radioisotopes from an underground nuclear explosion to seawater, to fish, to man. Source-term estimates of a Milrow-type device were used for computer calculations of the internal radiation dose from 53 radioisotopes on the basis of the intake starting 30 days following detonation. (C.H.)

49196 TABLE FOR THE NORMALIZATION OF TIME-DOSE RELATIONSHIPS. Kroening, Paul M.; Deiterman, Louis H. Jr. (Scott and White Clinic, Temple, Tex.). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 112: No. 4, 803-5(Aug 1971).

A table of fractional values to be used in calculating the Nominal Standard Dose (NDS) received by a patient during radiotherapy is presented. The fractional values are given for various combinations of treatment fractions (1 to 40) and total treatment times in days (1 to 50). When the fractional values are multiplied by the total dose, expressed in rads, the NSD is obtained, expressed in rets. (E.R.B.)

49197 RADIATION EXPOSURE OF THE HANDS DURING ADMINISTRATION OF RADIONUCLIDES IN MEDICINE. Husak, Vaclav; Kleinbauer, Karel; Lidova, Ludmila; Erban, Jiri (Palackeho Univ., Olomouci, Czech.). Jad. Energ.; 17: No. 5, 164-8(1971). (In Czech).

The radiation exposure of a worker's hands in nuclear medicine was determined on the surface of a syringe by means of intensity and time measurements. The integrated exposure resulting from a syringe filled with a radionuclide was calculated with the help of a simple formula, and then checked with a film dosimeter. The weekly exposure on the palms of a doctor working in the department of nuclear medicine at Olomouci varied from 0.5 to 1.5 R. A graph presents the growth of the total exposure of medical technologists in the department from 1965 to 1970. (tr-auth)

49198 SPECIFIC GAMMA-RAY AND EQUILIBRIUM ABSORBED-DOSE CONSTANTS FOR ^{135m}Ba. Syed, Ibrahim B.; Hosain, Fazle (Johns Hopkins Medical Institutions, Baltimore). J. Nucl. Med.; 12: No. 9, 630-1(Sep 1971).

Barium-135m, a potential radionuclide for bone scanning, has a half-life of 28.7 hr and emits 268-keV photons. The specific gamma-ray constant (Γ) was calculated. Methods of source calibration have been presented. The equilibrium absorbed-dose constant has been calculated and the radiation doses are 0.3 and 1.2 rads/mCi for the total body and the skeleton, respectively. (auth)

49199 TISSUE MAXIMUM-DOSE RATIO (Tmr) FOR 8 MV X RAYS. Agarwal, Suresh K.; Scheele, Ronald V.; Wakley, Jack (Univ. of Virginia, Charlottesville). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 112: No. 4, 797-802(Aug 1971).

The idea of tissue maximum-dose ratio (Tmr) is considered better than tissue air ratio and tissue phantom ratio for calculating dose at high energies. The T_{mr}'s for 8 MV x rays were calculated from percentage depth dose tables and are tabulated. The calculated data were compared with experimental measurements, and were found to be in good agreement. (auth)

49200 PLANNING OF SUPERVOLTAGE THERAPY OF MALIGNANT TUMORS USING ELECTRONIC COMPUTERS. Kozlov, A. P.; Afanasev, B. P. (Research Inst. for Oncology, Leningrad). Radiobiol.-Radiother.; 12: No. 1, 7-13(1971). (In German).

A program for the calculation of the whole dose field in the body of a patient is described that results from the irradiation of a tumor from several directions. Algorithms for the calculation of the dose in inhomogeneous media and values of the coefficients in the formula for this calculation are given for gamma radiation of the Rokus unit (SSD = 50, 60, and 75 cm) and for the bremsstrahlung of the medical betatron B 5 M-25 (SSD = 100 cm, maximum energy E = 12, 20, and 27 MeV without filter, E = 27 MeV with filter). The mean error of the dose calculation made by means of the found values of the coefficients does not exceed 3%. The program was established in the language of the electronic computer "Minsk 22" and permits to vary within wide limits such parameters of irradiation as the number and location of the points, radiation energy, SSD, irradiation dose and field size for each direction, to make dose corrections relative to the inhomogeneities of the medium and to the inclination of the radiation field to the surface of the body, and to calculate the whole dose field in one irradiation plane and the integral absorbed doses in given organs and tissues. (auth)

49201 COMPUTER EVALUATION OF IRRADIATION PROCESSES IN CYLINDRICAL CONTAINERS WITH GAMMA SOURCES. Purohit, K. S.; Manson, J. E.; Zahradnik, J. W. (Univ. of Massachusetts, Amherst). J. Food Sci.; 36: No. 5, 747-9(Jul-Aug 1971).

A numerical technique is presented for evaluating food irradiation processes using cylindrical gamma sources. Dose rate distributions obtained by dividing a container into finite concentric rings permit the use of a nonuniform initial spore load distribution and the determination of both number and distribution of survivors. The double integral giving dose rates was computed using several methods. The computations gave survivors significantly different from those obtained by using approximations given in

literature. Accurate evaluations require utilization of dose rate distributions in radial and axial directions. (auth)

49202 URANIUM CONCENTRATIONS IN SURFACE AIR AT RURAL AND URBAN LOCALITIES WITHIN NEW YORK STATE. McEachern, Peter; Myers, Willard G.; White, Frederick A. (Rensselaer Polytechnic Inst., Troy, N. Y.). Environ. Sci. Technol.; 5: No. 8, 700-3(Aug 1971).

The concentration of uranium in surface air at urban and rural locations within New York State was measured by both mass spectrometric and fission track analysis. Average uranium concentrations ranged from 0.10 to 1.47 ng/m^3 (0.035 to 0.47 fCi/m^3), with each area indicating that a significant correlation exists between the uranium concentration and the density of total suspended particulates. Present levels of uranium in the air environment are attributed primarily to naturally occurring uranium sources and nonnuclear industrial activity. In the immediate vicinity of a nuclear fuel reprocessing plant, a slight excess uranium was detected by observing the degree of ^{235}U enrichment. However, at all locations sampled, the uranium concentration is substantially below presently established standards. (auth)

Radiation Protection

Refer also to abstracts 48684, 49260, and 49262.

49203 (PHS-PUBL.-2016) RADIOLOGICAL HEALTH HANDBOOK. (Public Health Service, Rockville, Md.). Revised Edition Jan 1970. 61p. GPO $4.00.

The Radiological Health Handbook has been used as a basic reference for students and professional personnel in the field of radiological health during the past 20 years. Physical, chemical, and mathematical data; radioisotope, decay, and radioassay data; radiation protection data; the table of isotopes and the glossary have been up-dated. The ninth revision also includes a new chart of the nuclides, a universal decay table, microwave and lasar glossaries, a film-speed chart, and depth-dose tables. (C.H.)

49204 (UCRL-72848) SUGGESTED GUIDELINE FOR LOW-DOSE RADIATION EXPOSURE TO POPULATIONS BASED ON BENEFIT-RISK ANALYSIS. Cohen, Jerry J. (California Univ., Livermore. Lawrence Radiation Lab.). Jun 1971. 21p. (CONF-710710-8). Dep. NTIS.

From sixteenth annual Health Physics Society meeting; New York, N. Y. (12 Jul 1971).

The basis for standards set by the International Commission on Radiological Protection (ICRP), the National Council on Radiation Protection (NCRP), and the Federal Radiation Council (FRC) for the maximum permissible radiation dose of the general human population is critically reviewed. It is suggested that the recommendation of a maximum average radiation dose of 170 mrem/yr for human populations be abolished and replaced by the use of a new unit called the Mer. The Mer is defined as that amount of benefit required to justify an exposure to one rem. It is postulated that application of some form of benefit-risk analysis in deriving radiation guidelines would have the effect of placing low-dose exposure risks into commonly comprehensive perspective. (26 references) (C.H.)

Safety Procedures

Refer also to abstract 49261.

49205 (BNWL-CC-1906) SAFETY ANALYSIS REPORT: PLUTONIUM FUELS LABORATORY, 308 BUILDING. Lanning, D. D.; DeMerschman, A. W.; Hansen, J. E. (Battelle Pacific Northwest Labs., Richland, Wash.). Feb 1969. Contract AT-(45-1)-1830. 71p. Dep. NTIS.

The Plutonium Fuels Laboratory (308 Building), 300 Area, is operated for the USAEC by Battelle-Northwest Laboratories of the Battelle Memorial Institute. The Laboratory is specifically designed and constructed for the development and fabrication of experimental nuclear reactor fuels containing highly toxic radioactive materials. Several major activities are conducted within the building: plutonium fuels development, FFTF fuel fabrication, isotopic heat source development, and experimental studies of basic properties of radioactive materials. A safety analysis is presented of all the facilities and activities within the building, divided to describe each separately. Pertinent details on design and construction of the entire building are described. Nuclear safety limits for the entire building and for individual facilities therein are included. Interactions between the various facilities are discussed. (C.H.)

49206 RADIOIODINE THERAPY TO OUT-PATIENTS: THE CONTAMINATION HAZARD. Chandra, R.; Marshall, C. H. (New York Univ., N. Y.). Brit. J. Radiol.; 44: No. 523, 557 (Jul 1971).

It is suggested that contamination risks to contacts in the home from giving ^{131}I treatment to outpatients are greater than often believed. Omissions in some current calculation practice are pointed out and emphasis is laid on the importance of using the most pessimistic data available. (UK)

Civil Defense

Refer also to abstract 49303.

49207 (AD-714287) DESIGN AND APPLICATION OF A DECONTAMINATION AND DOSE CONTROL MODEL SYSTEM. Final Report. Owen, W. Leigh (Stanford Research Inst., Menlo Park, Calif.). May 1970. Contract DAHC20-70-C-0217. 186p. NTIS.

Survival from a contaminating nuclear attack may depend on capability to effectively implement fallout decontamination operations. The success of these and related recovery operations will require careful and extensive preplanning. Therefore, a decontamination and dose control (D/DC) model system was developed for determining feasible radiological recovery (Rad/Rec) plans and procedures consistent with overall postattack requirements. A test application of the model is made on a regional shopping center. (auth)

49208 (AD-719723) NUCLEAR EMERGENCY OPERATIONS PLANNING AT THE OPERATING ZONE LEVEL. Final Report. Rainey, Charles T. (Stanford Research Inst., Menlo Park, Calif.). Oct 1970. Contract DAHC20-68-C-0156. 56p. NTIS.

The study was concerned with the development of a prototype Nuclear Emergency Operations Plan for local jurisdictions of less than 25 square miles and for operating zones within larger jurisdictions. The emergency period considered begins with the onset of a crisis, includes the warning and attack phases, and continues until weapon-caused fires, if any, are out and fallout radiation, if any, no longer constitutes a substantial hazard. The prototype zonal NEOP consists of three parts. The first is the Basic Plan of the local government within which the zone is located. The second is a Master Checklist of preplanned actions. This checklist is based on the dynamics of the principal threats (direct effects and fallout) posed by nuclear weapons. All operating zones would use the same checklist except that those zones unlikely to experience direct weapons effects would require the fallout portions only. The third part contains service annexes that detail the plans for accomplishment of emergency actions within a given zone. (auth)

Legal Aspects

Refer also to abstracts 48836-48838.

49209 INTERNATIONAL COMMISSION ON RADIATION UNITS AND MEASUREMENTS (ICRU). REPORT TO THE INTERNATIONAL EXECUTIVE COMMITTEE OF THE XIIth INTERNATIONAL CONGRESS OF RADIOLOGY, TOKYO, 1969. Brit. J. Radiol.: 44: No. 523, 555-6(Jul 1971).

A brief resume of ICRU publications, its relationship with other organizations and its finances, is given with amplifying tabulations. (UK)

Medicine

Refer also to abstract 50591.

Protective Substances

Refer also to abstracts 49100, 49162, 49269, and 49297.

49210 (SGAE-SS-7/1971) RADIATION PROTECTION WITH PSYCHOTROPIC DRUGS. Summary Report and New Results. Locker, A.; Weish, P.; Krumpholz, H. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Institut fuer Strahlenschutz). [1970]. 91p. (In German). Dep. NTIS (U. S. Sales Only).

In GP-Swiss mice several neuroleptic psychotropic drugs, namely Fluanxol, Lidanil, Melleril, Sordinol and Truxal, have been tested for their ability to protect against lethal effects of whole-body irradiation with γ-rays. The same has been done with thymoleptics, namely Pertofran and Tofranil, in NF_1-mice; the effect being judged as increase in the percentage of surviving animals within 30 days after administration (i.p. injection) of the drug. All the compounds, in general, lower body temperature and whole-body metabolism of the animals. Whereas the thymoleptics do not exhibit any radioprotective effect, the neuroleptics exert a considerable radioprotection, in dependence upon the dose of the

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compounds and the time interval between injection and start of the irradiation. The effect is optimal if irradiation takes place at the moment when the physiological effects mentioned above are most pronounced. The effect reaches its optimum with Sordinol (20 mg/kg) when applied in female GP-Swiss mice 120 min before irradiation and amounts to more than 80% survivors as compared with 0% in the control series. With respect to the intensity of the radioprotective effect the neuroleptics can be arrayed as follows: Sordinol > Melleril > Truxal > Fluanxol > Lidanil. (auth)

49211 CHEMICAL RADIATION PROTECTION AND THE c AMP MECHANISM. Langendorff, H.; Langendorff, M. (Heiligenberg-Inst., Baden, Ger.). Int. J. Radiat. Biol.; 19: No. 5, 493-5(1971).

Experiments were made to test the relation between the cyclic adenosine monophosphate (c AMP) mechanism and the following radioprotective substances; – AET, ATP, 3′ – AMP and 5′ – AMP, lipopolysaccharide (LPS) of Escherichia coli origin, and p-aminopropiophane (PAPP). Survival of mice was decreased by administration of LB 46 (Visken), an inhibiting β-adrenergic drug, before the dose of radioprotective drug. Protection saturation occurred at levels of LPS above 15 μg LPS/mouse and was interpreted as being caused by a limited number of receptors being specific for that particular protector. Combinations of two drugs gave increased survival consistent with the existence of specific receptor sites for different protectors. Doses ranged from 699 to 1120R. (UK)

49212 RADIOSENSITIVITY CHANGES IN MICE UNDER THE ACTION OF PHENYLHYDRAZINE. Musta, I.; Uray, Z. (Oncological Inst., Cluj). Stud. Biophys.; 26: No. 1, 41-7(1971).

It was found that phenylhydrazine as an administered dose had a double effect on the radiosensitivity of mice. A dose of 10 mg/kg produced moderate radioprotection while a dose of 100 mg/kg produced a marked radiosensitizing effect. The registering of the development of the intrasplenic redox potential after administering phenylhydrazine let us explain this effect by the differences in the duration and intensity of the redox equilibrium alteration in the spleen as well as by the consequences of the change in redox conditions in the energetic metabolism and the recovery processes. (auth)

49213 EFFECT OF CYSTEINE ON THE RADIOSENSITIVITY OF ENDOGENOUS SPLEEN COLONY FORMING UNITS IN MICE. Kovacs, P.; Daroczy, A.; Hernadi, F. (Univ. Medical School, Debrecen, Hungary). Stud. Biophys.; 26: No. 1, 13-20(1971).

1000 mg/kg of L-cysteine-HCl.H_2O given 15 to 25 min prior to x irradiation of BALB/c mice increased the radiation resistance of endogenous spleen colony forming units (CFUs) by a factor of 3.36. At the same time, however, the "intercept value" was reduced by cysteine protection by a factor of about 24, indicating a decrease in the number of CFUs present in the unirradiated mouse due to cysteine treatment. (auth)

49214 SUPPRESSION OF RADIATION DAMAGE IN MICE BY THE POST-IRRADIATED ADMINISTRATION OF REDUCED GLUTATHIONE SALTS. Ueno, Y. (Kyoto Univ.). Stud. Biophys.; 26: No. 1, 1-5(1971).

The pharmacological action of reduced glutathione in x-irradiated mice was studied. The results indicated that the administration of glutathione after irradiation inhibited the reduction of intestinal weight and prolonged the survival time of lethally (GI death) irradiated mice. Administration of the lithium salt of the compound was more effective in both respects than was administration of the sodium salt. It was concluded that the radioprotective action of reduced glutathione consisted of a protective action and a suppressing action against radiation damage in vivo, and that the pharmacological action of radioprotectors in irradiated mammals must be taken into account in analyzing the mechanisms of radioprotection in vivo. (E.R.B.)

49215 RADIOPROTECTIVE AND BIOCHEMICAL PROPERTIES OF SELENIUM AS EVALUATED IN THE SELENIUM DEFICIENT RAT. Hurt, Harvey David. Ithaca, N. Y.; Cornell Univ. (1971). 143p. University Microfilms Order No. 71-15,631.

Thesis.

Selenium deficiency, uncomplicated by vitamin E deficiency, was produced in first generation, second and third litter rats from females maintained on a low selenium, vitamin E supplemented torula yeast diet. Reproduction of the females depleted of selenium, as part of the breeding colony, was not affected through the rearing of three litters. The selenium deficient offspring were characterized by a reduced hair production and slower growth rates as compared to the rats supplemented with 0.5 ppM selenium as selenomethionine. Low selenium purified amino acid diets were fed to normal weanling rats. The concentrations of selenium in the blood, liver, and skeletal muscle decreased rapidly for the first eight weeks. Further decreases in selenium concentrations of these tissues were negligible after 20 weeks. Concentrations of the element in the blood and liver continued to increase throughout the 20 week supplementation period and a difference in growth rate accompanied these changes in the rats supplemented with 0.5 ppM selenium as selenomethionine. The ability of selenomethionine to inhibit uncontrolled free radicals in vivo was tested by exposure of selenium depleted and selenium supplemented rats to whole body irradiation. Exposure to acute high dose rate x-irradiation of either 1350, 1550, or 1750 R given in two exposures 35 days apart or exposure to chronic ^{60}Cobalt gamma-irradiation for 20 hours per day with a total accumulation of 188 R per day did not demonstrate any beneficial effects due to high dietary selenium. Hematocrit, erythrocyte and total leukocyte concentrations following irradiation were not different between the two groups of rats. No difference in survival times was noted. The effect of selenium deficiency on the metabolic processes of the rat was characterized by a decrease in the rate of oxidation of pyruvate by liver mitochondrial preparations for deficient rats. Increases in blood lactate, pyruvate and glucose were observed in selenium depleted rats as compared to supplemented rats one hour after an oral dose of glucose. Increases in plasma lactate, liver lactate, acetate, and succinate accompanied by decreased urinary excretion of citrate, cisaconitate, isocitrate, and alpha-ketoglutarate concentrations were observed in selenium depleted rats as compared to concentrations noted for supplemented rats. No other changes in the end-products of glycolysis or the intermediates of the tricarboxylic acid cycle as determined by silicic acid partition column chromatography were observed between the two groups. (Diss. Abstr.)

49216 STUDIES ON THE RADIATION PROTECTIVE AGENTS FOR ORAL ADMINISTRATION. Akaboshi, Sanya (National Inst. of Radiological Sciences, Chiba, Japan). Genshiryoku Kogyo; 17: No. 2, 51-4(Feb 1971). (In Japanese).

Radiation protective agents are divided into the following groups from the view point of chemical protection: drugs effective as prophylactics when they are administered just before irradiation; drugs effective for radioisotope excretion; and drugs effective for recovery from or medical therapy of radiation injury. Synthetic studies were mainly made on AET-related compounds that are protective agents belonging to the first group. The protective effects of these agents were investigated with 4-week-old ddY mice as test animals. The merits of oral administration are a decrease of acute toxicity, prolongation of effectiveness, and usefulness for application to man. The following two compounds were developed in Japan, and proved to be effective: adrenochrome monoguanylhydrazone methanesulphonate (AMM, trade name is S-Adehnon) and L-cysteine ethyl ester hydrochloride (trade name is Cystanin). Since Cystanin is less toxic than conventional MEG and AET, and shows a protective effect, the combined effects of radiation therapy and administration of Cystanin on cancer and malignant tumors are being investigated. (Japan)

49217 STABILITY OF DNA, RNA, AND POLY (A + U) TO THERMAL DENATURING IN THE PRESENCE OF AMINOTHIOL RADIOPROTECTORS. Bogoyavlenskaya, N. V. (Inst. of Experimental Biology, Moscow). Biophysics (USSR) (Engl. Transl.); 15: No. 3, 421-5(1970).

Translated from Biofizika; 15: No. 3, 400-3(1970).

The profiles of the curves of fusion were studied in solutions of DNA from cattle liver, RNA from rat liver and dog spleen, poly A, and poly (A + U) at neutral pH during thermal denaturing in the presence of aliphatic diamino disulfides possessing radioprotective properties. It was shown that cystamine and bis-(2-aminopropyl) disulfide at concentrations of 1×10^{-3} M stabilized the molecules of DNA, RNA, and poly (A + U) on thermal denaturing and had no effect on the profiles of the curves of fusion of solutions of poly A. It was assumed that the mechanism of the stabilizing action by the diamino disulphides on the molecules of nucleic acids was based on the reaction of interaction of these compounds with heterogeneous nitrogenous bases of polynucleotide strands. (auth)

49218 MODIFICATION OF RADIATION INDUCED HEMOLYSIS BY RADIOSENSITIZING CHEMICALS IN MOUSE ERYTHROCYTES. Ueno, Y. (Kyoto Univ.). Stud. Biophys.; 26: No. 1, 7-11(1971).

The mechanism of the radiosensitizing effect of ametohepazone was studied using radioinduced hemolysis of blood from mice as the biological index. The results are compared to those for BUdR, a well known radiosensitizer. Addition of each compound to separate blood samples immediately before irradiation (^{137}Cs) resulted in the suppression of hemolysis at concentrations of 3×10^{-2} M and 3×10^{-4} to 3×10^{-8} M for ametohepazone and at 3×10^{-8} M for BUdR. Neither substance enhanced hemolysis. It

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was concluded that the enhancement of the partial destruction of the Na and K barrier in the cell membrane is not involved in the radiosensitization mechanism of either compound. (E.R.B.)

49219 COMPARATIVE STUDY IN IRRADIATED RATS, PROTECTED WITH CYSTEINE AND TREATED WITH NUCLEIC ACIDS. THE BONE MARROW AFTER ACUTE IRRADIATION. Gorun, Vera; Cutcudache, Caliopi; Popescu, Gh.; (and others). Doc. Haematol. (Bucharest); 1: 57-68(1968). (In Rumanian).

Changes in the bone marrow were studied in rats after exposure to 700 R of radiation, comparing the behavior of the marrow of unprotected rats with radiation-induced changes 2, 5, 10 and 15 days after the exposure. The animals were protected by treatment with cysteine or nucleic acids or both. Post-irradiation medullary smears revealed strong drops of the cell sera, except in the reticulo-histiocytic system. The stratum cells exhibited growth, regenerating the cell sera, especially on the fifth day after exposure. Administration of cysteine and nucleic acid, especially of the former, was found to exert a strong protective action; this was confirmed by the rapid growth of the myelogenous elements after the initial depression, better utilization of iron and a less marked drop of the blood serum. The actual mechanism of the protective action has not been fully clarified yet. (TTT)

Radiation Sickness and Injuries

49220 (AD-722970) RADIATION INJURIES AND SICKNESS. VOLUME I. Report Bibliography, May 1957-July 1970. (Defense Documentation Center, Alexandria, Va.). May 1971. 262p. (DDC-TAS-71-14-1). NTIS.

The annotated references were compiled from the Defense Documentation Center's data bank on injuries and sicknesses caused by radiation and radioactive decays. Indexes of corporate author-monitoring agency, subject, and title are provided in this bibliography. (auth) (USGRDR)

49221 EFFECT OF TORESTEN ON RADIATION SICKNESS. Tatsuno, Ikuro (National Hospital, Kanazawa, Japan). Rinsho Hoshasen; 15: No. 12, 913-15(Dec 1970). (In Japanese).

To 18 patients with malignant tumors who complained of radiation sickness during radiotherapy with Linac X ray, and to two patients with hyperthyroidism who suffered from radiation sickness after administration of ^{131}I, Toresten was administered orally with a daily dose of 13 to 19.5 mg for 3 to 81 days. Nausea and vomiting were improved rapidly. Of 20 cases, Toresten was remarkably effective in five, was effective in 12, and was ineffective in three. Toresten, which acts on the vomiting center and chemoreceptor trigger zone, and has relatively mild psychotropic and sedative actions, seems to be effective for treating radiation sickness and completing radiotherapy. As side effects of Toresten, drowsiness was complained of in several cases, and extrapyramidal symptoms such as dystonia and symptoms similar to Parkinson's disease were observed in one case. (Japan)

49222 PATHOGENESIS OF RADIATION HEMORRHAGE. Oivin, I. A.; Volodin, V. M.; Oivin, V. I.; Tokarev, O. Yu. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiol.-Radiother.; 12: No. 1, 53-61(1971). (In German).

In a total gamma irradiation as well as in a local x- or gamma irradiation of the skin of rabbits, the early reaction is a liquefaction of the matrix of the connective tissue (a depolymerisation of mucopolysaccharides) and the later reaction is a decreased mechanical stability (resistance) of the vessels. For all three types of irradiation, a dependence of the vascular resistance on the state of mucopolysaccharides of the skin could not be found. The changes of mucopolysaccharides were short in all cases but the disturbance of the resistance was long. The examinations of men, rabbits, guinea-pigs, and rats showed that the depolymerisation of mucopolysaccharides that is caused by the immediate effect of hyaluronidase is not reflected by the mechanical stability of the vessels. It was found in the experiments that the depolymerisation of mucopolysaccharides of the matrix of the cutaneous connective tissue that arises from a total irradiation does not play an essential part in the decrease of the mechanical stability of the vessels. It was shown that the rise of the hemorrhage in radiation sickness cannot be completely explained by thrombocytopenia and changes of the function of thrombocytes. The possible importance of the changes within the vessels, of the state of the collagenous and elastic fibres of the perivascular tissue in the pathogenesis of disturbances of the mechanical stability of the vessels as the original cause of the development of the hemorrhagic syndrome in a radiation sickness was discussed. (auth)

Radiodiagnosis

Refer also to abstracts 48463, 49080, 49096, 49184, 49198, 49305, and 49313.

49223 (CONF-710402-(Vol.2), pp II.49-58) NEUTROGRAPHY IN MEDICAL RESEARCH AND PATHOLOGY. Flynn, Michael J.; Knoll, Glenn F.; Poznanski, Andrew K. (Michigan Univ., Ann Arbor).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

The results of research in three areas of bio-medical applications of neutron radiography are reported. Neutrographs from thick bone sections are presented and analyzed with respect to their tissue types and extent of tumor involvement. The contrast provided by various high cross section elements in biological material was analyzed and the results for boron-10 contrast were compared with experiment. A concept for micro-neutrography is presented and its application to biological studies is briefly discussed. The necessity of using reaction rate average cross sections in predicting the image response of thick organic objects is stressed, and the results presented are supplemented by several tables of microscopic and macroscopic cross sections along with contrast parameters calculated by a reaction rate analysis. (auth)

49224 (CONF-710402-(Vol.2), pp II.59-60) NEUTRON RADIOGRAPHY IN DENTAL DIAGNOSIS. Weisman, Manuel I. (Veterans Administration Hospital, Augusta, Ga.); Brown, Mark (Medical Coll. of Georgia, Augusta).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

Neutron radiography has been felt to have a potentially useful role in the diagnosis of dental disease processes, particularly those involving the pulp of the tooth. Experiments were carried out to determine the applicability of the technique for use in a clinical situation. Radiographs comparing x-ray and neutron dental radiographs were obtained. Although additional information could be obtained using neutron radiography, the image quality was inferior. The technique was not thought to be clinically applicable because of a combination of physical, biological dose, and fiscal factors. (auth)

49225 (UCLA-12-815, pp 99-141) NUCLEAR MEDICINE. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology).

In Annual progress report June 30, 1971.

Recent advances in radioisotope organ imaging using either rectilinear scanners or stationary γ cameras are reviewed. Some 25 papers published during the period covered by this report are included that discuss the diagnostic accuracy of various scintigraphic methods. (C.H.)

49226 ^{99m}Tc-SULFUR COLLOID ABSORBED ON FERRIC HYDROXIDE MACROAGGREGATES FOR LUNG PERFUSION IMAGING. Huberty, J. P. (Univ. of California, San Francisco). Int. J. Appl. Radiat. Isotop.; 22: No. 7, 425-7(Jul 1971).

A simple 10-min technique is described for the preparation of technetium-sulfur colloid labeled macroaggregates for imaging in lung perfusion studies. These highly reproducible particles are characterized by a 90% particle distribution within the 20 to 90 micron range. Less than 0.5% TcO_4^- or technetium-sulfur colloid remains in the product, and localization in the lungs of white mice is 97% ± 0.8, 30 min after injection. (auth)

49227 MODIFIED METHOD OF BONE SCANNING USING ^{18}F. Buttfield, I. H. (Royal Brisbane Hospital, Queensland, Australia). At. Energy Aust.; 14: No. 2, 24-7(Apr 1971).

A simple and reliable scanning table is described. It was designed to allow whole-body profile scanning and whole-body counting when used in conjunction with a dual-headed rectilinear scanner. The table is particularly useful when used in conjunction with ^{18}F. The technique allows rapid imaging, gives satisfactory geometry and allows whole-body scanning with no loss in diagnostic efficiency. (Australia)

49228 COMPARISON OF THYROID IMAGES OBTAINED BY A CONVENTIONAL SCINTIGRAPHIC DEVICE AND BY A SPARK CHAMBER CAMERA. Riviere, R.; Morucci, J. P.; Dutheil, M.; Kellershohn, C. (CEA, Orsay France. CEA, Saclay, France). J. Biol. Med. Nucl.; 6: No. 23, 17-27(1971). (In French).

The ideal field of application of the spark chamber camera is the morphological study of the thyroid gland with iodine-125. To a high pressure (1.5 atmosphere) spark chamber was adapted a silver collimating grid (thickness 20 mm, hole diameter 1 mm) giving an excellent resolution. Theoretical studies on the statistical and particularly the geometrical resolution show the superiority of such a stationary detector over a conventional scintigraphic device. This superiority is confirmed by the presentation and comparison of many thyroid images obtained with the two

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processes. Special emphasis is placed on the possibility of revealing small cold nodules difficult or even impossible to detect by scintigraphy. (auth)

49229 REPEATED MEASUREMENTS ON BLOOD FLOW AND CARDIAC INDEX AFTER OPERATIONS INVOLVING EXTRACORPOREAL FLOW. Roche, P. (CEA, Orsay, France); Courau, F.; De Vernejoul, P.; Mathey, J. Arch. Mal. Coeur Vaiss.; 63: No. 8, 1106-18(Aug 1970). (In French).

Sixteen cases were studied; the blood flow, and the cardiac index in the immediate follow-up after extracorporeal flow (70 measurements) were measured using ^{131}I labeled human albumin. A fall in the cardiac index was detected during the first few hours. The measurements are rapid and lead to absolute values for the flow. (auth)

49230 NEW MEASURING METHOD FOR CORONARY BLOOD FLOW USING ^{86}Rb. Di Matteo, J. (Hopital Necker, Paris); Vacheron, A.; Sabaut, D.; (and others). Arch. Mal. Coeur Vaiss.; 63: No. 12, 1657-72(Dec 1970). (In French).

It is possible to measure directly the coronary output without cardiac catheterization by dilution curves with red blood corpuscules labelled with ^{99m}Tc and ^{86}Rb. These two indicators are injected simultaneously by the intravenous route. Their intracardiac dilution curves are recorded by one single scintillation detector connected to two electronic units. The coronary output is obtained from the difference between the areas of the left peaks of the two curves. These peaks which result from the passage of the indicators into the left ventricle represent indeed the only part of the curves during which a fraction of the indicators circulate in the coronary vessels and during which ^{86}Rb is fixed electively by the myocardium. Fourty one subjects were studied. The results obtained were correlated with clinical symptoms, electrocardiographic, and for a certain number of patients, coronarographic results. This study confirms the priviledged character of the coronary circulation which protects the myocardium from anoxia in cases of decreased systemic output. It assesses the hemodynamic changes resulting from coronary atherosclerosis and myocardial infraction. (auth)

49231 HEPATIC SCINTIGRAPHY WITH ^{131}I-LABELLED ALBUMINE MACROAGGREGATES (APPLICATION TO THE DIAGNOSIS OF HEPATIC TUMORS). Sicot, C.; Moine, C.; Hoanca, O.; Nahum, H.; Benhamou, J. P. (Hopital Beaujon, Clichy, France. Hopital Beaujon, Paris). J. Biol. Med. Nucl.; 6: No. 23, 28-34(1971). (In French).

Hepatic scintigraphy was performed on 13 cases of hepatic tumors after injection of AMA-^{131}I into the coeliac trunk. A hyperfixation in the tumoral zones is a strong indication of malignancy. Comparison of these results with data obtained by arteriography and ^{198}Au scintigraphy can contribute usefully to the diagnosis of liver tumors. (auth)

49232 COMPARISON OF RESULTS OF PULMONARY ARTERIOGRAPHY AND RADIOISOTOPE LUNG SCANNING IN THE DIAGNOSIS OF PULMONARY EMBOLI. Linton, Donald S. Jr.; Bellon, Errol M.; Bodie, John F.; Rejali, Abbas M. (Case Western Reserve Univ., Cleveland). Contract W-31-109-Eng-78. Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 112: No. 4, 745-8(Aug 1971).

Pulmonary scanning is an accurate, but nonspecific, method of evaluating pulmonary perfusion as shown by a high degree of correlation with pulmonary arteriography and plain film findings (94% over-all agreement). Where the scan was negative, the pulmonary arteriogram was also negative in all cases. Approximately one-half (54%) of the scan abnormalities found were associated with disease processes other than embolism in spite of the clinical suspicion of embolism that led to the performance of the examinations. This finding is of clinical importance in terms of patient treatment and suggests that positive scans should be followed up by arteriography for complete evaluation. A simple method of pulmonary arteriography and scanning is described. (auth)

49233 THYROIDAL PERTECHNETATE UPTAKE IN HASHIMOTO'S DISEASE. Hauser, Wolfgang; Atkins, Harold L.; Eckelman, William C.; Richards, Powell (Brookhaven National Lab., Upton, N. Y.). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 112: No. 4, 720-5(Aug 1971).

Two conditions other than hyperthyroidism will lead to an elevation of the thyroidal pertechnetate uptake. The first situation is in patients taking medication containing estrogens. The second situation is in patients with chronic thyroiditis. In patients with this disorder, the pertechnetate uptake was consistently higher than expected from over-all thyroid function. In 19 patients the mean pertechnetate uptake was 5.18 ± 2.73 percent compared to a mean of 1.69 ± 0.77 percent in 53 patients with nontoxic nodular goiter. This finding is of importance because it aids in the diagnosis of Hashimoto's disease without surgery and it allows identification of individuals who may become hypothyroid in the future. (auth)

49234 CLINICAL APPLICATION OF THE BROAD SPECTRUM SCANNING AGENT: ^{113m}In. Adatepe, Mustafa H.; Welch, Michael; Evans, Ronald G.; Potchen, E. James (Washington Univ., St. Louis). Contract AT(11-1)-1653. Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 112: No. 4, 701-6(Aug 1971). (COON-1653-83).

Indium-113m is a transition metal obtained by eluting a tin-113 generator system with HCl. The complexing ability of the eluted indium allows for one-step chemical preparation of organ specific scanning agents. Indium-transferrin is used for plasma volume estimation and cardiac blood pool-placental scanning; indium-phosphate colloids are used for reticuloendothelial scanning, i.e., liver, spleen, and bone marrow; indium-DPTA chelates are used for brain and kidney scanning; and indium-iron hydroxide macroaggregate is used for perfusion lung scans. Clinical experience in over 1,000 patients suggests that these agents are at least as effective as previous scanning radiopharmaceuticals. The short half life of the indium (100 min) and the long half life of the tin (118 days) allow for frequent elution of the generator in a clinical setting. This markedly decreases cost and obviates the need for storage of various isotopes at varying decay rates. The one-step process also eliminates the need for sophisticated radiochemical preparation prior to each scan. This availability of an inexpensive broad spectrum scanning agent may permit a more widespread application of diagnostic nuclear medicine procedures where they are now not feasible. (auth)

49235 REGIONAL CEREBRAL BLOOD FLOW MEASUREMENT WITH ^{133}Xe AND THE SCINTICAMERA. Torizuka, Kanji; Hamamoto, Ken; Morita, Rikushi; (and others) (Kyoto Univ.). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 112: No. 4, 691-700(Aug 1971).

Regional cerebral blood flow was measured by the ^{133}Xe clearance method in patients with intracranial lesions by a combination of scinticamera, 1,600 channel analyzer, and computer compatible magnetic tape. The data were processed by means of a FACOM 230-60 digital computer. The cerebral blood flow index in each element was calculated by the height/area method from the ^{133}Xe washout curve in each element, was divided into eight levels, and was printed out with a line printer, represented by codes, symbols, and letters. The regional blood flow for the entire cerebrum was described as one representation. The higher flow indices were observed in the peripheral zone of the cerebral hemisphere and in the region of the insula or basal ganglia in the healthy subjects; and the various changes were represented in the maps in various cerebral diseases. This flow index map is exceedingly practical for obtaining a single display of regional functions of the entire cerebrum. The effect of nicotinamide on cerebral blood flow was studied in three cases. Nicotinamide was found to increase blood flow in the white matter, but not in the gray matter in arteriosclerotic brain disease. These findings show that the combined use of the scinticamera, 1,600 channel analyzer, magnetic tape, and digital computer is very valuable in the dynamic study of organ circulation. (auth)

49236 INTRAVENOUS RADIOISOTOPE ANGIOGRAPHY WITH COMPUTER PROCESSING OF DATA. Loken, Merle K.; Ponto, Richard; Bache, Robert; Burchell, Howard (Univ. of Minnesota, Minneapolis). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 112: No. 4, 682-90(Aug 1971).

Four studies are considered to illustrate a technique for intravenous radioisotope angiographic evaluation of patients with cardiac disorders. Although the various pictorial presentations including cinefilm have proven valuable in these studies, there has been the addition of computer processing of data, provided a quantitative approach to be made for better evaluation of the clinical status of patients with cardiac problems. Despite its limitations, this technique for processing of data obtained with a scintillation camera has proven useful. The major limitation is the inherent dead time during which the data in memory are being read onto the magnetic tape (approximately 0.2 sec). This, together with the data collection time of 0.6 sec means that data points are obtained at 0.8 sec intervals. For the cases presented here, this does not represent a serious problem in interpretation of results. However, for optimal evaluation of cardiac shunts and incompetent cardiac valves, shorter time intervals for data transfer are needed in order to relate data points to cardiac systole and diastole. At present we are considering other techniques for data acquisition that will permit this to be done. (auth)

49237 EVALUATION OF CORRECTIVE SURGERY FOR PANCREATITIS BY ^{75}Se SELENOMETHIONINE PANCREATIC

IMAGING. A CASE REPORT. Eaton, S. Boyd Jr.; James, A. Everette Jr.; Potsaid, Majic S.; Nardi, George L. (Massachusetts General Hospital, Boston). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 112: No. 4, 678-81(Aug 1971).

This report describes a patient with well documented chronic pancreatitis whose preoperative ^{75}Se selenomethionine pancreatic scintigram failed to demonstrate the pancreas. Six months after sphincterotomy and sphincteroplasty, pancreatic function testing and the pancreatic scintigram became normal. The value of pancreatic imaging in providing an objective means of assessing the physiologic efficacy of operation for chronic pancreatitis is discussed. (auth)

49238 VALUE OF RADIOISOTOPE SCANNING IN THE INVESTIGATION OF SUSPECTED CARCINOMA OF THE PANCREAS. Heslip, P. G.; Overton, T. R. (Univ. of Alberta, Edmonton). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 112: No. 4, 667-77(Aug 1971).

Abnormal pancreas scans were obtained in 14 patients with proven carcinoma of the pancreas. Unfortunately, the scan appearance with carcinoma is not completely diagnostic, since chronic pancreatitis can produce the same type of scan abnormality. It has been our experience, however, that carcinoma of the pancreas produces much more distortion of pancreatic architecture and a more irregular distribution of radioisotope than chronic pancreatitis, in which pancreatic morphology is relatively intact and radioisotope concentration is often severely but fairly uniformly decreased. Two patients with well-documented evidence of chronic pancreatitis and intermittent jaundice were discovered to have abnormal pancreas scans of this type. Seven patients presented with obstructive jaundice and were subsequently proven to have extrapancreatic disease as the basis of their biliary obstruction. These patients had normal pancreas scans and, in fact, pancreas visualization was considered superior to that seen in most normal patients. There is a possibility that this phenomenon is related to a normal pancreatic uptake of radioisotope and a decreased uptake in the liver due to depression of hepatic metabolism. It is apparent from the cases presented that pancreas scanning is very useful in the evaluation of patients with obstructive jaundice and also of patients with carcinoma of the pancreas without jaundice. In patients with obstructive jaundice but without pancreatic disease, normal or even enhanced pancreatic uptake and subsequent visualization appear to be present. The theoretical reasons for this phenomenon are briefly discussed. (E.R.B.)

49239 NEUROFIBROMA MIMICKING A PAROTID GLAND TUMOR BOTH CLINICALLY AND BY SCANNING. Wilkinson, Robert H. Jr.; Goodrich, Jack K. (Duke Univ., Durham, N. C.). J. Nucl. Med.; 12: No. 9, 646-8(Sep 1971).

A case report is presented in which the superimposition of a tracer accumulating neurofibroma and normal salivary gland led to an erroneous clinical and scan impression of a tracer accumulating parotid tumor or unilateral hypertrophy. This possibility should be kept in mind in the evaluation of tracer accumulating parotid tumors identified on salivary gland scans. (auth)

49240 PRACTICAL COMPROMISE IN BONE SCANNING. Braunstein, P.; Hernberg, J. G.; Chandra, R. (New York Univ., N. Y.). J. Nucl. Med.; 12: No. 9, 639-40(Sep 1971).

Miniaturization may to some degree compensate for decreased detected information density, and this allows a scan speed fast enough to make large-area or whole-body bone screening with ^{85}Sr feasible. Simple photographic miniaturization appears to be an adequate way to achieve this and thus to bring the capabilities for this type of examination to any department with a simple rectilinear scanner and facilities for making 35-mm or Polaroid transparencies. (auth)

49241 METHOD USING A DIGITAL COMPUTER FOR REDUCING RESPIRATORY ARTIFACT ON LIVER SCANS MADE WITH A CAMERA. Oppenheim, Bernard E. (Univ. of Chicago. Argonne Cancer Research Hospital, Chicago). J. Nucl. Med.; 12: No. 9, 625-8(Sep 1971).

A method has been devised for significantly reducing the respiratory motion artifact in liver images made with a gamma camera and recovering the information that has been lost by this motion. Other than data processing equipment, no ancillary devices are required. The method does not require patient cooperation, does not modify the technique of the study, and is not impaired by irregularities in the patient's respiration. The method uses a medium size computer as an interface and a large computer for processing. The effectiveness of the method has been demonstrated in phantom studies. A new interface is being constructed which should permit the successful application of this method to clinical material. (auth)

49242 RADIOAEROSOL INHALATION LUNG SCANNING: ITS ROLE IN SUSPECTED PULMONARY EMBOLISM. Isawa, Toyoharu; Hayes, Michael; Taplin, George V. (Harbor General Hospital, Torrance, Calif. Univ. of California, Los Angeles). J. Nucl. Med.; 12: No. 9, 606-9(Sep 1971).

Radioisotope perfusion lung scanning is useful in the diagnosis and management of pulmonary embolism. However, scan findings are often misleading in patients with underlying obstructive airways disease. Fortunately, radioaerosol inhalation scans demonstrate whether the ischemic regions are aerated in addition to showing other evidence of obstructive airways disease. Seventy-three suspected pulmonary embolism patients were examined with both perfusion and radioaerosol inhalation scans on the same visit. Twenty-eight with aerated ischemic regions were diagnosed and treated for pulmonary embolism. Forty-three with nonaerated ischemic regions showed scan evidence of obstructive airways disease. Most of these could have been misdiagnosed and improperly treated for pulmonary embolism without the radioaerosol scan information. Although concurrent small emboli could not be excluded in this group, aerosol scan evidence for or against airways disease was helpful in the differential diagnosis of pulmonary embolism. (auth)

49243 ^{125}I-LABELED CHLOROQUINE ANALOG IN THE DIAGNOSIS OF OCULAR MELANOMAS. Boyd, Charles M.; Beierwaltes, William H.; Lieberman, Lionel M.; Bergstrom, Terry J. (Univ. of Michigan, Ann Arbor). J. Nucl. Med.; 12: No. 9, 601-5 (Sep 1971).

Two millicuries of ^{125}I-labeled analog of chloroquine were given orally to patients with intraocular malignant melanomas and patients without ocular pathology. Radioactivity in each of the two eyes was compared by external counting. Results demonstrated that melanotic melanomas show a significantly higher than normal counting rate over the tumored eye 14 days or more after the dose; amelanotic melanomas may concentrate the tracer equally well before 14 days but apparently lose the tracer at a faster rate; non-melanoma lesions show a counting rate within the normal range. It is suggested that the diagnosis of ocular malignant melanoma, under the experimental conditions described, can presently be made with a 95% confidence when the mean difference in counting rate between the two eyes is 18% after 14 days with the higher counting rate over the eye with the lesion. (H.L.W.)

49244 USEFULNESS AND RELIABILITY OF SHORT-LIVED RADIONUCLIDES FOR CARDIAC OUTPUT DETERMINATION. Myers, J. Hurley; Steadham, Roy E.; Blackwell, L. H. (Univ. of Tennessee, Memphis). J. Nucl. Med.; 12: No. 9, 591-5(Sep 1971).

A study is presented of cardiac output determinations with ^{99m}Tc and ^{113m}In compared with indocyanine green dye in the dog as well as the volume flow of a circulation model. The results indicate that both nuclides can be used for accurate determination of cardiac output with little or no preparation after they have been eluted from the nuclide generator. A simple method of computation of cardiac output from curves generated by a recording ratemeter is discussed. The importance of a circulation model for calibration of cardiac output equipment is emphasized. (auth)

49245 EVALUATION OF A ^{133}Xe VENTILATION TECHNIQUE FOR DIAGNOSIS OF PULMONARY DISORDERS. Farmelant, Melvin H.; Trainor, James C. (Saint Vincent Hospital, Worcester, Mass. Boston Univ.). J. Nucl. Med.; 12: No. 9, 586-90(Sep 1971).

Forty-two patients had perfusion and serial radioxenon ventilation scintigrams. Radioxenon was administered in a single vital capacity breath and scintigrams made of the single-breath distribution, the distribution at equilibrium and serially during washout. Normal perfusion and single-breath ventilation were present in a small group of patients with acute bronchitis and in single patients with pulmonary carcinoma and mild pulmonary edema. Washout was abnormal in three of these. A perfusion defect with normal single-breath ventilation was present in each of 15 patients with pulmonary embolism. Three additional patients with asthma, asthmatic bronchitis, and an upper-lobe fibrotic lesion had similar patterns. Trapping during washout in the asthmatic patient was of discriminatory value. Corresponding perfusion and single-breath ventilation defects were present in patients with pulmonary infiltrates or chronic obstructive disease. The distribution after equilibration was abnormal only in two patients with completely nonaerating regions of lung. Segmental trapping during washout and half-times of equilibration curves were sensitive indicators of mild ventilatory difficulty but were of differential diagnostic value only occasionally. (auth)

49246 RESULTS OF ^{75}Se-SELENITE TUMOR SCINTIGRAPHY. Thiemann, G.; Holldorf, M.; Schwartz, K.-D. (Univ., Rostock, Ger.). Radiobiol.-Radiother.; 12: No. 1, 109-16(1971). (In German).

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Since 1965, ^{75}Se-selenite is recommended for positive tumor scintigraphy. Different authors report good results of examination and obtained a detection probability up to 80%. Among the author's patients, the findings of 34 patients with malignant tumorous diseases were evaluated for whom tumor scintigraphy was made after intravenous administration of 200 to 400 μCi ^{75}Se-selenite 24 to 72 hr after injection. The results did not reach the detection probability given in literature although the affinity in metastases of carcinomas of the cervix and of the breast is expressed compared with bronchial carcinomas. For examinations of pelvic and abdominal tumors, control scintigrams are necessary in order to avoid false positive results due to the retention of the substance in the liver, kidneys, and intestinal tract. The use of ^{75}Se-selenite for younger patients in the sense of a test for the detection of the tumor cannot be recommended. (auth)

49247 BEHAVIOR OF ERYTHROCYTE KINETICS OF PATIENTS WITH PANMYELOPATHY. Schulz, K.; Nowotny, P.; Konrad, H.; Preussner, S.; Kiencke, H. (Medical Univ., Rostock, Ger.). Radiobiol.-Radiother.; 12: No. 1, 103-8(1971). (In German).

Erythrocyte kinetics of 32 patients with differently marked panmyelopathy was examined partly by ^{59}F, partly by ^{51}Cr. The results were compared with clinical and hematological findings. The significance of nuclear medical methods of examinations for the judgement of bone-marrow activity of patients with panmyelopathy is emphasized. (auth)

49248 IMPORTANCE OF THE COMPARTMENT TRANSPORT RATE CONSTANTS OF BENGAL-RED METABOLISM AND OF SCINTIGRAPHY IN FUNCTION TESTS OF THE HEPATOBILIARY SYSTEM. Varl, B.; Hribar, M. (Univ., Ljubljana, Yugoslavia. Institut Josef Stefan, Ljubljana, Yugoslavia). Radiobiol.-Radiother.; 12: No. 1, 79-86(1971). (In German).

Following the intravenous administration of ^{131}I-Bengal-red, surface measurements of the activity were made over the head, liver, and intestine. The transport rate constants that yield numerical information on the absorbing, accumulating, and secretory function of the liver were calculated from the activity over the head by means of a simple analogue computer according to the mathematical analysis of the kinetic model for Bengal-red. The values of the single transport rate constants showed an overlapping for different diseases of the liver and of the gall-passages so that they have no importance for differential diagnosis. In connection with the results of the intestinal activity curve and of scintigraphy of the liver, gall bladder, and intestine, however, they may give essential information on the type of the disease of the liver and gall-passage. They are an important enlargement of the hitherto used diagnostical methods especially for icteric patients. (auth)

49249 BIOMEDICAL APPLICATIONS OF NEUTRON RADIOGRAPHY. Whittemore, William L.; Boyne, Philip J. (Gulf General Atomic Co., San Diego, Calif. Univ. of California, Los Angeles). Res./Develop.; 22: No. 7, 22-4(Jul 1971).

The development of neutron radiography as a diagnostic and analytical technique of a nondestructive nature applicable to medical clinical situations is discussed. Neutron sources currently in use are discussed and a typical medical neutron radiography system is described. The limitations of existing systems, for medical diagnostic procedures, are detailed and the possibilities for future applications in vivo are presented. The techniques for neutron- and x-radiography are compared. (E.R.B.)

Radiotherapy

Refer also to abstracts 48913, 49078, 49173, 49174, 49190, 49196, 49199, 49200, 49304, 49309, 49310, 49312, 49323, 50466, and 50598.

49250 (AD-714490) RADIATION EFFECTS IN MAN: MANIFESTATIONS AND THERAPEUTIC EFFORTS. Annual Report, May 1, 1968-April 30, 1969. Saenger, Eugene L.; Silberstein, Edward B.; Horwitz, Harry; Kereiakes, James G.; Chen, I-Wen (Cincinnati Univ., Ohio. Coll. of Medicine). Oct 1970. Contract DA-49-46-XZ-315. 48p. (DASA-2428). NTIS.

The goal of this program has been to obtain new information regarding the pathophysiologic, psychologic, immunologic, hematologic, and biochemical effects of whole- and partial-body irradiation in human beings. The patients are irradiated, all of whom have inoperable, metastatic carcinoma but are in relatively good health, to provide the opportunity to study multiple facets of the effects of radiation in man rather than in experimental animal. The data contained in this report will suggest several potential biological dosimeters previously considered to be of some value. Biochemical and psychological studies have extended the findings of a previous report in depth and scope. Success has finally been obtained in autologous marrow infusion that will permit usage of higher doses of radiation. Several new biological dosimeters are under evaluation. The only change in physical dosimetry was the addition of partial-body radiation from sternum to pubis for selected patients. (auth)

49251 (CONF-710402-(Vol.2), pp II.1-6) NEUTRON RADIATION THERAPY. Catterall, Mary; Thomlinson, R. H.; Field, S. B. (Hammersmith Hospital, London (England)); Rogers, Charles C. (Virginia Commonwealth Univ., Richmond).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

Before a controlled clinical trial of fast neutrons is started on the Medical Research Council's cyclotron at Hammersmith Hospital, London, a preliminary investigation is being conducted on patients with advanced malignant tumors. The treatment and early observations on 72 such patients treated with fast neutrons since November 1969 are described. The dose rate is 40 rads per min with treatment times of 3 to 4 min per field. This enables flexibility of the patient's position during treatment and overcomes the disadvantages of the fixed horizontal beam. Collimation is by borated wooden tubes; wedge filters can be used as in conventional radiotherapy. A dose of neutrons of about 1 rad per 1000 rads administered is received by the patient's eyes. A total dose of 1440 rads given in 12 fractions over 25 days was found to be a practical therapeutic regime resulting in healing of skin reactions and regression of tumors. With this fractionation of 120 rads, the RBE for skin is about 2.9. Treatment times of 40 to 50 days were used in the most recently treated patients with doses of 1512 and 1576 rads given in 12 or 15 fractions. A clinically significant skin sparing effect was demonstrated. (auth)

49252 (CONF-710402-(Vol.2), pp II.22-8) PRELIMINARY CLINICAL EXPERIENCE WITH ^{252}Cf INTERSTITIAL SOURCES. Castro, Joseph R. (Anderson (M. D.) Hospital and Tumor Inst., Houston, Tex.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

Californium-252 fast neutron emitting interstitial sources were utilized in the treatment of locally advanced or widely disseminated human squamous cancers. A clinical RBE factor of 5 was utilized to convert the doses from rads (neutron plus gamma) to rem. A percutaneously inserted nylon tubing system was utilized with dummy sources placed for radiographic localization, and the radioactive sources afterloaded behind special shielding after the patient had returned to his room. Dosage ranged from 4,000 rem in 40 to 100 hrs by californium-252 alone to 7,500 rem in six weeks when combined with external irradiation. Although the tumor dosage was lower than desirable because of difficulties with manual and computer dose calculations, most of the patients have had local control of their tumors. A controlled clinical trial will be necessary to compare the effectiveness of californium-252 to radium-226 for interstitial and intracavitary usage. (auth)

49253 INVESTIGATION INTO THE CLINICAL EFFECTS OF FAST NEUTRONS. METHODS AND EARLY OBSERVATIONS. Catterall, Mary; Rogers, Charles; Thomlinson, R. H.; Field, S. B. (Hammersmith Hospital, London). Brit. J. Radiol.; 44: No. 524, 603-11(Aug 1971).

The early observations on 35 patients treated since November, 1969 with fast neutrons from the M.R.C.'s cyclotron at Hammersmith Hospital are described, together with the methods used to select a practical therapeutic regime, and investigate the effects of bolus, skin sparing and determine the RBE for skin. Eighteen patients required radiation to more than one area and these treatments were given by both high and low LET radiations. The skin reactions produced were compared by a system of skin scoring and the tumour responses by measurements made as objectively as possible. The dose-rate of 40 rads per min resulted in treatment times of less than four minutes per field and enabled patients to be treated in the kneeling and sitting as well as the lying position, thus overcoming the disadvantages of the fixed horizontal beam. Collimation of the beam was good and wedged filters could be used as in conventional radiotherapy. Doses received by the eyes were approximately 1 rad per 1,000 rads to the treatment area. The RBE for skin for neutrons at 120 rads per fraction appeared to be 2.9. There was a clinically significant skin sparing effect. 1,440 rads of neutrons in 12 fractions over 26 days to a 90 cm^2 area caused a skin reaction that healed in all cases and also caused satisfactory tumour regression. (auth)

49254 PRESENT STATUS OF RADIOTHERAPY. Yamashita, Hisao (Keio Univ., Tokyo). Sogo Rinsho; 19: No. 5, 978-85 (May 1970). (In Japanese).

Recent progress in the radiotherapy of cancer is reviewed. Therapeutic methods include treatment with radium, x rays, γ rays, electron beams and other particles, and radioisotopes taken internally. Some practical examples for radium therapy by the after-loading system are given. In x-ray therapy, the combined use of sieve irradiation with high-voltage x rays of over 250,000 V has improved the permanent cure rate of lung cancer. In super-high voltage x-ray therapy, the linear accelerator has made it possible to use x rays of 2 to 8 million volts. In γ-ray therapy, high-dose telecobalt therapy has been developed and this has become one of the best means of therapy. Electron beam therapy with a betatron has given marked results if the cases are chosen correctly, while treatment with neutrons, mesons, and α-rays awaits future development. Injection of radioisotopes like ^{131}I and ^{198}Au colloid produces a specific therapeutic effect in addition to their affinity to specific organ tissues. Gold-198 colloid is especially effective for cancerous pleuritis. In order to carry out the most appropriate treatment with radiation, treatment planning with the use of simulator-planning apparatus and computers is being made. Improvement in the therapeutic effect is attempted by combination of radiotherapy with surgery, and the efficacy of preoperative irradiation is now widely recognized. Use of antitumor agents and chemicals that potentiate the action of radiation is also increasing. (Japan)

49255 RADIOTHERAPY IN ORAL SURGERY FIELD. **Shigematsu, Yasushi (Osaka Univ.). Shikai Tenbo; 35: No. 6, 1284-90(Mar 1970). (In Japanese).**

The technique of radiotherapy of malignant tumors in the field of oral surgery is reviewed and some experimental results are reported. Indication of radiotherapy should take into consideration the correlation between the radiosensitivity of the tumor and the tolerance of the peripheral tissue, which is expressed by a therapeutic ratio. Treatment under hyperbaric oxygen is one of the representative examples for improving this ratio. For combination with surgery, radiotherapy is used at the time of, before, or after surgery. Postoperative irradiation is used to treat the residual cancer cell and prophylactic small-dose irradiation is not effective. Combination of radiotherapy with chemotherapy is chiefly made to increase the radiosensitivity of the tumor to prevent metastasis. The treatment consists of intra-arterial injection for the former and oral or intravenous administration for the latter to effect systemic application. For radiotherapy of the oral field, a ^{60}Co apparatus (2000 Ci) and small-dose sources (over 10 needles or tubes) are used. Since the tumor is usually visible, small-dose therapy is important for curative treatment. Intra-oral irradiation by electron beam for primary tongue cancer and remote irradiation with ^{60}Co γ rays for progressive cases are widely employed. For cancer of the oral floor, which is poorly tolerable to radiation, radium needling results in necrosis. Percutaneous irradiation is effective for lymph node metastasis. Gingival cancer also has poor toleration and percutaneous irradiation of super-high voltage x rays and γ rays is used, but its recurrence rate is high. Maxillary cancer is often accompanied by osteoclasis and in such a case, irradiation should be given first and surgery should be determined from its result. In order to see the effectiveness of radiotherapy combined with continuous intra-arterial injection of anticancer agent and/or sensitization agent, some control trials were carried out and it was found that some tumor inhibition could be expected by intra-arterial injection of cyclohexanol succinate. (Japan)

49256 RADIOIODINE THERAPY OF THYROTOXICOSIS. **Jackson, G. L. (Harrisburg Hospital, Pa. Pennsylvania State Univ., University Park). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 112: No. 4, 726-31(Aug 1971).**

A review of the Harrisburg Hospital experience in treatment of hyperthyroidism with low administered doses of ^{131}I is presented. The incidence of hypothyroidism is 11%. Hypothyroidism was most frequently diagnosed within 4 months of treatment. Three percent of patients remain hyperthyroid. It is presumed that additional ^{131}I in this group will result in a satisfactory clinical result. (auth)

49257 INTRA-ARTERIAL IRRADIATION OF TUMORS, A SAFE PROCEDURE. **Simon, Norman; Silverstone, Sidney M.; Roach, Lawrence C.; (and others) (Mount Sinai School of Medicine, New York). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 112: No. 4, 732-9(Aug 1971).**

Intra-arterial irradiation with beta emitters such as ^{32}P and ^{90}Y is relatively safe to staff, and the complications are few. Accurate placement of the arterial catheter is crucial. Confirmation of the placement with angiograms is mandatory, and the outlined precautions are necessary. Bremsstrahlung scans verify the position of the radioactive material, but only after it has been injected. The benefits of intra-arterial irradiation exceed the risks in the treatment of some tumors of the brain and liver. The pulmonary, renal, and femoral arteries may also be injected safely with radioactive microspheres. (auth)

49258 VALUE OF POSTOPERATIVE INTRAPERITONEAL INJECTION OF RADIOCOLLOIDS IN EARLY CANCER OF THE OVARY. **Hilaris, Basil S.; Clark, Donald G. C. (Memorial Hospital, New York). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 112: No. 4, 749-54(Aug 1971).**

From April 1956 to September 1965, 57 patients with Stage I cancer of the ovary were treated. The over-all 5 yr survival rate of these patients is 78% (44/57). Radioactive colloidal phosphorus (^{32}P) was used in 26 patients (46% of all patients). The 5 year survival rate for the patients with and without ^{32}P is 92% (24/26) and 64% (20/31), respectively. There is no evidence of any major adverse effect, either in the postoperative period or at a later date, attributable to the instillation of ^{32}P. It appears that the postoperative instillation of ^{32}P decreases the incidence of local (intra-abdominal) recurrences, but owing to the small number of patients, no definite conclusions can be drawn. The main argument for the use of colloidal phosphorus postoperatively is the simplicity of administration and the absence of administration and the absence of severe side reactions and late effects, which are associated with the use of total abdominal irradiation. (auth)

49259 SECOND LOOK SURGERY AFTER RADIATION THERAPY FOR ADVANCED STAGES OF CANCER OF THE OVARY. **Tepper, Erwin; Sanfilippo, Louis J.; Gray, John; Romney, Seymour L. (Albert Einstein Coll. of Medicine, Bronx, N. Y.). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 112: No. 4, 755-9(Aug 1971).**

A series of 17 patients with advanced ovarian carcinoma who had exploratory laparotomy, 3,000 rads abdominopelvic irradiation, thioTEPA, and second look surgery is reported. Tumor regression was complete or sufficient to permit gross total removal of the tumor in 9 of 17 cases. Microscopic disease was present in all cases, however. A 3 year survival of 41 percent was achieved. The average survival of all cases was 29 months; 20 months free of recurrence. Three of the 17 cases remain free of disease from 48 to 77 months. (auth)

49260 SYNCHRONOUS SHIELDING AND FIELD SHAPING FOR MEGAVOLT IRRADIATION OF ADVANCED CERVICAL CARCINOMA. **Ilfeld, David N.; Wright, Kenneth A.; Salzman, Ferdinand A. (Massachusetts Inst. of Tech., Cambridge. Lahey Clinic Foundation, Boston). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 112: No. 4, 792-6(Aug 1971).**

A method of synchronous shielding and field shaping for megavolt x-ray rotational therapy of carcinoma of the cervix is presented. Metal absorbers protect the bladder, rectum, and small intestine during 360° rotation while other blocks contour the shape of the x-ray beam to the known and estimated tumor volume. Tests with a masonite phantom indicate a tumor dose homogeneity of ±10%. The head of the femur received 30 to 50%, the bladder 60 to 85%, the rectum 60 to 70%, and the small intestine 30 to 70% of the tumor dose. This technique optimizes the tumor dose relative to the adjacent normal tissue dose, thereby permitting higher radiation levels to be delivered to the entire tumor by external irradiation alone. (auth)

49261 SURFACE APPLICATORS AND INTERSTITIAL IMPLANTATIONS WITH RADIOACTIVE ^{192}Ir. **Jayachandran, C. A. (Christian Medical Coll., Vellore, India). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 112: No. 4, 740-4(Aug 1971).**

Iridium-192 is a better material than ^{198}Au for surface applicators using intermittent applications over a period of 2 to 6 days. The activity per applicator is about 50% as compared to that with ^{198}Au for a given case. The dose to personnel is as low as 13 mR/hr. at 50 cm. from the surface of the applicator containing about 8 mCi ^{192}Ir. This dose could be further reduced to negligible proportions by a lead shield of 2 to 3 mm. In the case of radium, the dose would be much higher and a larger thickness of lead sheet would be required for a comparable reduction in dose at 50 cm. While loading the applicator with ^{192}Ir, the protection required is reduced nearly to one-third of that required for radium. The distribution rules given are more convenient for use by the clinician in terms of effort and time. For the interstitial application of ^{192}Ir, special apparatus, like the gold grain gun, is not essential. Hospitalization of the patient can be minimized. (auth)

49262 SIMPLE BOLUS MOULD FOR INCREASING SURFACE DOSE WITH HIGH ENERGY BEAMS. **Scheele, R. V.; Turner, J. W. Jr.; Hurtt, Faye; Constable, W. C. (Univ. of Virginia, Charlottesville). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 112: No. 4, 764-5(Aug 1971).**

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The skin sparing from 8 MV. roentgen rays was reduced by devising a felt-wax bolus pad. It was found to be easy to manufacture, convenient to use, of relatively uniform thickness, and economical. (auth)

49263 HISTOCHEMICAL STUDIES ON CELLULAR RESPONSE OF HUMAN SKIN CANCER IN THE COURSE OF X-RAY THERAPY. Vorbrodt, A.; Hliniak, A.; Niepolomska, W. (Inst. of Oncology, Gliwice, Poland). Radiobiol-Radiother.; 12: No. 1, 15-24(1971).

Two groups of patients with skin cancer were observed in the course of x-ray treatment with a single exposure of 2500 R, or with fractionated therapy of 5000 R in 17 daily exposures. The biopsy specimens taken before and in one week intervals in the course of therapy, were examined histopathologically and histochemically. The localization of lipids and acid and alkaline phosphatases was studied. The obtained results indicate, that acid phosphatase-rich phagocytes are engaged in deterioration of cancer foci. The vascularization of the tumor is changed as a result of x irradiation. The fragmentation of cancer foci and proliferation of blood vessels suggest the better oxygenation of cancer cells in the course of fractionated irradiation. The increase of lipids content in cancer cells is, in our opinion, the evidence of postirradiation injury. (auth)

49264 RESPONSE OF THE OVERACTIVE THYROID TO RADIOIODINE THERAPY. Spencer, Richard P. (Yale Univ., New Haven). J. Nucl. Med.; 12: No. 9, 610-15(Sep 1971).

Dividing the population receiving radioiodide therapy for hyperthyroidism into two groupings (cured and not cured) leads to quantitative expressions for the results which can be made to agree closely with actual data. A series of linear formulations are presented which may be of use in comparing populations and in testing the validity of proposed theories of the mechanism of action of radioiodide. (auth)

49265 FAST NEUTRONS AND π^- MESONS IN CANCER THERAPY. Boone, Max L. M.; Wiley, Albert L. Jr. (Univ. of Wisconsin, Madison). IEEE (Inst. Elec. Electron. Eng.). Trans. Nucl. Sci.; NS-18: No. 3, 36-45(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Fast neutrons and π^- mesons are discussed in terms of their potential application to radiotherapy of human cancer. (W.H.K.)

49266 INTERSTITIAL IRRADIATION OF CERVICAL METASTASES OF CANCER OF THE MOUTH WITH ^{192}Ir. Jucker, C.; Squassabia, A. (Univ., Pavia, Italy). Radiaz. Alta Energ.; 10: No. 1, 47-63(Jan 1971). (In Italian).

Ten patients with inoperable cervical node metastases (the site of cancer was the oral tongue or the floor of the mouth) were treated by interstitial irradiation (Henschke method): implant of nylon ribbons and ^{192}Ir wires as radiation sources. The technique has proved satisfactory (some cases of local sterilization 1 or 2 years after treatment were reported). (auth)

49267 METASTASES FROM ANAPLASTIC THYROID CARCINOMA RESPONDING TO RADIOIODINE. Donovan, J. K.; Ilbery, P. L. T. (Royal Prince Alfred Hospital, Sydney). Clin. Radiol.; 22: No. 3, 401-4(Jul 1971).

A case of carcinoma of the thyroid with metastases is reported in which there was a satisfactory response to radioiodine therapy 14 yrs after the original histological diagnosis of anaplastic carcinoma. Either differentiation occurred (in contrast to the usual tumor progression) or this anaplastic tumor was capable of radioiodine uptake. In either event, reliance on the histology as a guide to whether a patient should be treated with ^{131}I is refuted. It is suggested that patients with anaplastic lesions should not be excluded from a therapeutic trial of radioiodine. (auth)

49268 PIONS AGAINST CANCER. Brit. Med. J.; 3: No. 5771, 388-9(14 Aug 1971).

During the past half century, in the treatment of cancer, the contribution of technology has greatly increased. The newest arrival on the radiotherapeutic scene is the negative pion, a nuclear particle mass intermediate between the electron and proton, usually produced by the bombardment of a metal target by high energy protons from a cyclotron or synchrotron, and having three properties attractive for radiotherapy. Maximum radiation dose, in contrast with x rays, is well below the skin surface so there is less danger to adjacent healthy tissue. The linear energy transfer is much greater for pions at the end of their path than for x rays, but until this point the energy is much the same. Consequently, the effect on the tumor is about twice as great, whereas there is further reduction in the possibility of damaging healthy tissue. The pions will also be more effective in dealing with hypoxic cells. These predictions cannot be tested, there being insufficient pion source output. The clinical merits of this treatment are still uncertain, in spite of advantages (shared by fast neutrons), for tumor size and shape cannot be accurately estimated, and there is often projection into other tissue. If neutron radiotherapy proves to have clinical advantages, further consideration should be given to negative pion treatment. (UK)

Blast and Thermal Effects

Refer also to abstract 49303.

Radiation Effects on Animals

Refer also to abstracts 49080, 49099, 49114, 49162, and 49319.

49269 (NYO-3609-4) INVESTIGATION OF THE RADIOPROTECTIVE AND MITOGENIC PROPERTIES OF A YEAST EXTRACT IN HUMAN CELLS (HeLa-S_3) IN VITRO. Final Report. Gandini, Enrico [Ferrara Univ. (Italy). Istituto di Genetica Umana). [17 Aug 1971]. Contract AT(30-1)-3609. 19p. Dep. NTIS.

Following addition of Saccharomyces cerevisiae extract to cultures of HeLa cells a reversible mitotic lag was observed. Mitotic frequency was not affected by x radiation when yeast extract was added before or after irradiation. The efficiency in preventing the radioinduced mitotic lag was dependent on the extract dose and cell concentration of the culture. Striking similarities were observed between the reactions of the cultures of x radiation and to the crude extract. It was concluded that protection from the mitotic lag after sublethal doses of x radiation was due to products that could be isolated from the culture medium after addition of crude extract. (H.L.W.)

Invertebrates

Refer also to abstracts 49150, 49155, 49328, and 49339.

49270 EFFECTS OF RADIATION ON POPULATIONS OF DROSOPHILA MELANOGASTER WITH DIFFERENT GENETIC STRUCTURES. I. CHANGES IN FITNESS AND PRODUCTIVITY. Dyer, K. F. (Monash Univ., Clayton, Australia). Aust. J. Biol. Sci.; 24: No. 3, 565-73(Jun 1971).

It has been shown in previous work that heterozygotes between irradiated and non-irradiated populations of D. melanogaster experience a marked reduction in competitive ability. The effects of allowing the nucleus of a heterozygote gene pool to develop are here investigated and it is found that the total number emerging from a cage containing irradiated, non-irradiated, and heterozygote flies is considerably increased and the number of heterozygotes themselves shows almost a 100% increase. It is concluded that the opportunity given to the heterozygotes to form an integrated gene pool allows them to overcome much of their competitive disability. Further experiments involving three irradiated populations and the three possible hybrids between them which could be formed at each generation showed that these hybrid populations, although having similar radiation histories and containing similar genetic material, had a competitive ability reduced by over half or even three-quarters in many cases, compared with the parental population. It appears that it is the nature of the gene pool rather than its heterozygosity or the individual genes contained in it which largely determines the fitness and competitive ability of the population. (auth)

49271 EFFECTS OF RADIATION ON POPULATIONS OF DROSOPHILA MELANOGASTER WITH DIFFERENT GENETIC STRUCTURES. II. TEMPORAL CHANGES IN THE SEX RATIO. Dyer, K. F. (Monash Univ., Clayton, Australia). Aust. J. Biol. Sci.; 24: No. 3, 575-83(Jun 1971).

The effect of 1500 R x-rays, delivered for several generations to populations of D. melanogaster, on the sex ratio of the flies emerging has been examined. The results have been compared with those from similar populations living in the same environment but not given any radiation treatment. The mean values of four irradiated populations, when compared with their unirradiated counterparts, showed an initial drop in sex ratio followed by a marked recovery particularly between generations 7 and 12. When composite populations were set up, combining males from one irradiated population with females from another at each generation, this recovery in sex ratio was not observed. It was concluded that this latter result ruled out chromosomal phenomena and indicated a biometrical explanation as the most likely one for the observed rise in sex ratio with accumulated ancestral radiation in integrated gene pools. (auth)

49272 VISUAL RESPONSE OF THE PURPLE SHORE CRAB, HEMIGRAPSUS NUDUS, TO IONIZING AND NON-IONIZING RADIATIONS. Jordan, N. M.; Kimeldorf, D. J. (Oregon State Univ., Corvallis). Experientia; 27: No. 6, 653-5(15 Jun 1971).

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In the eye of Hemigrapsus nudus, electroretinographic (ERG) reactions could be elicited with visible light as well as with x rays. The reactions indicated that the two types of radiation caused the same rhodopsin-stimulation process. Findings with ^{90}Sr β radiation led to the conclusion that the β-ERG reaction is strongly influenced by both Čerenkov effect and induced light fluorescence. (tr-auth)

49273 EFFECT OF γ RADIATION ON VARIOUS DEVELOPMENTAL STAGES OF CORCYRA CEPHALONICA STN (GELLERIDAE LEPIDOPTERA). Hugue, H. (Dept. of Plant Protection, Karachi, Pakistan). Int. J. Appl. Radiat. Isotop.; 22: No. 7, 439-41(Jul 1971).

Studies were conducted to find out the effect of γ radiation on the survival and fecundity of the rice moth (Corcyra cephalonica). Observations revealed that freshly laid eggs were more susceptible than other stages in the life cycle. The dose of 25.0 KR was found sufficient to prevent further propagation of this pest. (auth)

49274 EFFECTS OF GAMMA RADIATION ON THE BEET ARMYWORM, SPODOPTERA EXIGUA (HUBNER) (LEPIDOPTERA: NOCTUIDAE). Rajasekhara, Koosappa. Berkeley, Calif.; Univ. of California (1970). 85p. University Microfilms Order No. 71-15,871.

Thesis.

The effects of gamma radiation on the beet armyworm, S. exigua, were determined in the laboratory using small cages. The insects were mass reared on a semi-defined diet. The early developmental stages were the most susceptible to injury by gamma radiation. Young eggs did not hatch after an exposure of 2 krads. Although eggs irradiated at 2 krads just before eclosion hatched, there was considerable mortality and deformity in the ensuing stages. Exposure of mature larvae to 6 krads resulted in 33% mortality before pupation. All of the adults were deformed and did not mate. Mature pupae and newly emerged adults were very similar in their sensitivity to radiation. Exposure of male pupae and adults to dosages below 55 krads caused little deformity or premature mortality. A dosage of 50–60 krads was required to reduce hatchability approximately 98%. After considering mating, oviposition, longevity and hatchability, 60 krads was determined to be the optimum dosage for inducing dominant lethality in pupae and adults. Female pupae and adults were considerably more susceptible to radiation injury than the males; 35 krads caused 99% sterility. Radiation retarded development of subsequent stages. Longevity of the adults was not a sensitive indicator of the amount of radiation damage. There was no indication of recovery from the initial reduction in fertility during the relatively short life of the moths. Because the females are more sensitive to radiation injury, both sexes could be released without danger of these females laying viable eggs. The reduced competitiveness of the sperm from irradiated males would require releasing very high numbers of irradiated males to bring about population reductions. Such a mass rearing program would not be practical at the present time. However, further research is still warranted because there is good evidence that reduced dosages will result in high sterility in the F_1 progeny. It will have to be determined if the sperm is more competitive at these lower dosages. (Diss. Abstr.)

49275 GAMMA IRRADIATION OF THE EUROPEAN CHAFER. 3. LONGEVITY, FLIGHT BEHAVIOR, AND MATING COMPETITIVENESS OF STERILIZED MALES, WITH OBSERVATIONS ON REPRODUCTIVE BIOLOGY. Chung, S. L.; Tashiro, H.; Massey, L. M. Jr. (New York State Agricultural Experiment Station, Geneva). J. Econ. Entomol.; 64: No. 4, 883-6 (Aug 1971).

Adults of Amphimallon majalis (Razoumowsky), were sterilized with gamma irradiation at a dose of 5000 rad (5 krad). Males and females treated with 10 krad had average life spans 1.4 days shorter for males and 1.5 days longer for females than averages of 14.9 and 19.2 for normal males and females, respectively. These differences are not significant. Males exposed to 5, 7.5, and 10 krad and released in a 42 × 20 × 14-ft screen cage showed no significant difference in flight activities or longevities from normal beetles. Increasing the ratio of sterilized males to a pair of normal beetles reduced total egg production and reduced viable egg production to an even greater extent. Combining 12 irradiated males with 1 normal male and female reduced fertile egg production most during early season. (auth)

49276 GAMMA IRRADIATION OF THE EUROPEAN CHAFER. 2. DETERMINATION OF STERILIZATION DOSE LEVELS FOR ADULTS, WITH NOTES ON REARING TECHNIQUES. Chung, S. L.; Tashiro, H.; Lippold, P. C.; Massey, L. M. Jr. (New York State Agricultural Experiment Station, Geneva). J. Econ. Entomol.; 64: No. 4, 832-7(Aug 1971).

Laboratory-reared virgin adults of Amphimallon majalis (Razoumowsky) were obtained by collecting third-stadial grubs in the spring, isolating individuals in 1-oz plastic cups containing seeded sterilized soil, and incubating them at 18.3°C and 75 to 80% RH. A 70% recovery as adults resulted. Doses of gamma radiation required for sterilizing adults differed between sexes and also between laboratory-reared and field-collected beetles. For SD_{95}, (sterilization dose) laboratory-reared beetles required 5400 rad (5.4 rad) for males and 1.2 krad for females. Field-collected beetles required 4.1 krad for males and 0.9 krad for females. Histological evidence indicates disruption of sperm bundles in the funnel region of testicular follicles. (auth)

49277 EFFECTS OF SUBSTERILIZING DOSES OF RESERPINE AND GAMMA IRRADIATION ON REPRODUCTION OF THE TOBACCO BUDWORM. Guerra, A. A.; Wolfenbarger, D. A.; Lukefahr, M. J. (Dept. of Agriculture, Brownsville, Tex.). J. Econ. Entomol.; 64: No. 4, 804-6(Aug 1971).

A combination consisting of 0.1% (wt/v) reserpine incorporated in the larval diet plus treatment of the resulting pupae with 7.5 krad of gamma irradiation was tested in the laboratory to determine whether it would sterilize Heliothis virescens (F.) without adversely affecting the life cycle, sexual behavior, and adult longevity. The two substerilizing treatments induced complete sterility in females, but the fecundity and fertility of untreated females mated with treated males were reduced only 24 and 49%, respectively, compared with untreated moths. Sexual behavior (spermatophore transfer) and adult longevity were not adversely affected. (auth)

49278 STERILIZATION OF THE MEDITERRANEAN FRUIT FLY BY IRRADIATION: COMPARATIVE MATING EFFECTIVENESS OF TREATED PUPAE AND ADULTS. Ohinata, K.; Chambers, D. I.; Fujimoto, M.; Kashiwai, S.; Miyabara, R. (Dept. of Agriculture, Honolulu, Hawaii). J. Econ. Entomol.; 64: No. 4, 781-4(Aug 1971).

Treatment of male Ceratitis capitata (Wiedemann) as 2-day-old adults with 10-krad gamma irradiation did not reduce their mating effectiveness; however, the same treatment applied to pupae 2 days before adult eclosion reduced mating effectiveness about 50%. Treatment of the pupal stage with substerilizing doses of 2.5 and 5 krad did not reduce mating effectiveness, but there was no indication of hereditary transmission of sterility when partially sterile flies or their progeny were outcrossed with untreated flies. (auth)

49279 GAMMA IRRADIATION OF THE EUROPEAN CHAFER. I. IRRADIATION OF THIRD-STADIAL LARVAE, WITH OBSERVATIONS ON SPERMATOGENESIS. Chung, S. L.; Lippold, P. C.; Tashiro, H.; Masey, L. M. Jr. (New York State Agricultural Experiment Station, Geneva). J. Econ. Entomol.; 64: No. 4, 823-32(Aug 1971).

Gamma irradiation levels for LD_{50} values on 3rd-stadial larvae of Amphimallon majalis (Razoumowsky) were 5300 rad (3.3 krad) for fall-collected individuals and 7.1 krad for spring-collected individuals when exposed as mature 3rd-stadial grubs approaching the prepupal stage. Serial sections of grubs exposed to doses of 0.5 to 50 krad all showed visible cytological injury to the germinal cells with pycnotic nuclei present in the treated testicular follicle. Male 3rd-stadial grubs were consistently more susceptible to gamma irradiation than females; exposure to 1 krad in the former produced comparable effects in emergence as 2.5 krad in the latter. Both male and female adults emerging from grubs treated at 2.5 krad had deformed wings. Grubs exposed to lower doses produced beetles with slightly shorter elytra than adults from nonirradiated grubs. Dose requirement for completely sterilizing larvae was higher than that for completely inhibiting metamorphosis. (auth)

49280 COMBINATION OF GAMMA AND INFRARED RADIATION FOR CONTROL OF THE ANGOUMOIS GRAIN MOTH IN WHEAT. Cogburn, Robert R.; Brower, John H.; Tilton, Elvin W. (Dept. of Agriculture, Savannah, Ga.). J. Econ. Entomol.; 64: No. 4, 923-5(Aug 1971).

Samples of "Hard Red Winter" wheat containing eggs, larvae, or pupae in known stages of development of Sitotroga cerealella (Olivier) were irradiated with gamma and IR (infrared) radiation. Representatives of each age group received the following treatments: (1) IR radiation, (2) gamma radiation, (3) IR radiation followed by gamma radiation, or (4) gamma radiation followed by IR radiation. Effectiveness of treatments was determined on the basis of percentage of adult emergence. Sequence of radiation treatments did not influence average effectiveness of the combinations. An average reduction in emergence of 52.2 and 55.3% was observed following gamma and IR radiation, respectively. When gamma treatment was followed by IR radiation, average reduction

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in emergence was 93.0%; and when IR radiation was followed by gamma radiation, 92.8% reduction occurred. The calculated expected average reduction was 78.6% for either combination. (auth)

Vertebrates

Refer also to abstracts 49110, 49115, 49151, 49159, 49210–49215, 49218, 49219, and 49222.

49281 (AD–716615) RADIOBIOLOGY OF LARGE ANIMALS. Annual Report. Jones, David C. L.; Krebs, John S. (Stanford Research Inst., Menlo Park, Calif.). Aug 1970. Contract DAGC20-70-C-0219. 47p. NTIS.

The relationships between dose rate and radiation response were studied in sheep and in mice. For sheep, the LD 50/60 varies inversely with dose rate, even when the dose rate is several hundreds of R/hr. An initial exposure to as little as 10 R (midline-air) at a high dose rate appears to affect the pattern of injury accumulation during subsequent low dose-rate exposure. The LD 50/60 for sheep exposed at 0.84 R/hr appears to be well in excess of 800 R. Continuous exposure to death at 3.8 R/hr results in a compression in survival time, so that all animals die within a period of seven days. Studies in mice indicate that there is no simple direct dependency of LD 50/30 on fractional survival of hematopoietic stem cells as the LD 50/30 increases with decreasing dose rate. A technique for evaluating erythroid activity in the bone marrow has been used to demonstrate that increased erythroid activity can occur in mice at a time post-irradiation when marrow cellularity is depressed. This technique has been found to be feasible for future irradiation studies using sheep. (auth)

49282 (AD–721698) CARDIOVASCULAR RESPONSE OF MONKEYS TO SUPRALETHAL DOSES OF MIXED GAMMA–NEUTRON RADIATION. Turbyfill, C. L.; Kieffer, V. A.; Dewes, W. A. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Nov 1970. 21p. (AFRRI-SR–70-10). NTIS.

Monkeys were given a pulsed dose of 2000, 4000, 15,000, or 50,000 rads of mixed gamma-neutron radiation to determine if changes in the cardiovascular system occur before or during early transient incapacitation (ETI) which may contribute to the decrement observed after supralethal doses of radiation. The mean arterial pressure, heart rate, blood volume, and some plasma chemistry values were determined in catheterized monkeys maintained in restraining chairs before and for 1 hour following irradiation or until death. The mean arterial pressure decreased significantly within 1 to 2 minutes following irradiation in the 2000-, 4000-, and 15,000-rad groups and remained depressed until 10 to 20 minutes postexposure before returning toward normal values. No significant decrease in the mean arterial pressure was observed in the 50,000-rad group until 25 to 30 minutes post-irradiation. The heart rate increased significantly in the 4000-, 15,000-, and 50,000-rad groups following irradiation. No significant changes were observed in the blood volume or plasma components measured. It appears that the mechanisms which result in an early temporary postirradiation hypotension in the monkeys at the lower supralethal doses of radiation are either inhibited or destroyed with a 50,000-rad dose. (auth)

49283 (CEA-CONF–1782) RELATIVE BIOLOGICAL EFFECTIVENESS OF 3-GeV PROTON BEAMS IN PRODUCING CATARACTS IN RABBITS. Legeay, G.; Haye, C. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires); Drouet, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Bazin, J. P. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1971. 19p. (In French). (CONF-710423–7). Dep. NTIS (U. S. Sales Only).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

The production of cataracts in rabbits with monoenergetic beams was studied as a function of the relevant parameters. The experimental conditions and the physical, biological and opthalmologic data are reviewed. The rabbits were divided into groups corresponding to different doses. The latency time parameter and the dose-effect correlation enabled the RBE to be determined. The latency time was determined as a function of the dose rate for the various stages in the irradiation with gamma rays and a 3 GeV proton beam; the response functions were then plotted using logarithmic coordinates. The RBE increases with decreasing doses. The time necessary for a cataract to appear and the degree of development depend upon the dose rate. (France)

49284 (CONF-710402–(Vol.2), pp II.29–36) CYTOGENETIC DETERMINATION OF THE OER AND RBE OF ^{252}Cf. Bushong, Stewart C.; Prasad, Naresh; Briney, Sharon A. (Baylor Univ., Houston, Tex. Coll. of Medicine); Oliver, George (Anderson (M. D.) Hospital and Tumor Inst., Houston, Tex.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

The RBE and OER for californium-252 were determined on the basis of chromosome damage in Chinese hamster ovary cells. The cells were cultured in vitro and were suspended in a 12 mm diameter tube in McCoy's medium without serum for irradiation. The tube was positioned in a polystyrene irradiation jig with either californium or radium sources located concentrically at a distance of 9 mm from source center to cell suspension center. The californium source loading of 46 μg resulted in a dose rate of 60.4 rads/hr with a neutron-to-gamma ratio of 1.41. The radium dose rate of 57.8 rads/hr resulted from a source loading of 40 mg. During irradiation the cell suspension was aerated with either oxygen or nitrogen containing less than ten ppM oxygen contamination. Following irradiation the cells were placed in tissue culture flasks in fresh medium and incubated for ten hours. Colchicine was added to a concentration of 1 μg/ml and incubated for an additional two hours. The cells were harvested, cytogenetic slides were prepared, and the slides were scanned for chromosome aberrations. Statistical analysis of the single-hit chromosome aberration frequency resulted in linear regression equations. The ratio of the dose coefficients of these equations showed an RBE of 3.48 under aerobic conditions and 4.61 under anaerobic conditions. The OER for the radium exposures was 2.32 while that for the californium exposures was 1.75. A therapeutic gain factor of 1.33 was demonstrated. Experiments are in progress at higher dose rates in order to extend the total dose range of this study. (auth)

49285 (ORO–681) ANNUAL PROGRESS REPORT, JANUARY 1–DECEMBER 31, 1970. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Jul 1971. Contract AT-40-1-GEN-242. 103p. Dep. NTIS.

Studies were continued on the effects of prenatal irradiation on the reproductive system and growth of bovine and porcine species. Emphasis was placed on quantitative and qualitative aspects of the evolutionary pattern of the germ cell and associated gonadal structures. Pregnant rats were exposed to various doses of gamma radiation for studies on effects of prenatal irradiation on growth of organs as well as on content of proteins and nucleic acids in the cerebral cortex. Studies were continued on effects of whole-body irradiation on reproduction and longevity of the progeny of a herd of Hereford cattle known as the life study herd. Studies on placental transfer of ^{134}Cs and ^{85}Sr in swine were completed and investigations were begun on effects of prenatal irradiation on the kidney, central nervous system, and cardiovascular system. Experiments with birds showed that chicks hatched from eggs irradiated during incubation grew more slowly than control chicks over a seven week period. Studies on late effects included gamma and neutron irradiation of burros in order to determine effects on longevity and physiology of specific organ systems. Studies were also conducted on late effects of whole-body gamma radiation on the work performance and related physiology of Shetland ponies. Research on early effects included irradiation of leukocytes of swine to study effects on chromosomes and nuclear volume. Analyses of blood and urine of animals were made for fatty acids formed by irradiation. Studies were continued on effects of acute radiation exposure on iron kinetics in sheep. Yttrium-90-labeled sand was used for studies on effects of ingested fallout simulant on young grazing livestock and to study the interaction of whole-body gamma irradiation with beta irradiation of the skin and gastrointestinal tract. Studies were conducted on the uptake of ^{75}Se, ^{54}Mn, and ^{59}Fe by erythrocytes of sheep following ^{90}Y beta irradiation of the skin and gastrointestinal tract and ^{60}Co gamma irradiation of the whole body. Metabolic effects of skin radiation injury were studied following exposure to sealed ^{90}Sr–^{90}Y plaques. Results of research on metabolism are reported for the following projects: radioiodine and dairy cattle; relationship of the thyroid gland and calcium metabolism in the bovine; metabolism of fission products and related nuclides in poultry; and effect of radiation on the intestinal absorption of fission products and related nuclides. Research on soil chemistry included studies on the dissipation of tritiated water in confined soil systems and diffusion in complex systems. Research on plants was concerned with control and modification of seed radiosensitivity and included the following studies: storage effect following neutron irradiation of barley seeds; effectiveness of fission neutrons versus gamma rays in barley seeds treated under controlled conditions of seed water content and atmosphere; effects of ionizing radiation on seeds of various species; and alteration of radioinduced chromosome to chromatid breaks in barley seeds. A list of 33 publications is appended. (H.L.W.)

49286 (UCB–34-P–82-11) ELECTROPHYSIOLOGICAL AND BIOCHEMICAL STUDIES OF THE EFFECTS OF RADIATION ON

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BRAIN ACTIVITY AND DEVELOPMENT. Progress Report, August 1, 1970–July 31, 1971. Timiras, Paola S. (California Univ., Berkeley). Contract AT(04-3)-34. 17p. Dep. NTIS.

The effects of various doses of x radiation delivered to the whole-body or head only of rats aged 10 to 60 days on the activity of acetylcholinesterase and choline acetyltransferase in brain tissues and subcellular fractions of brain cells were studied. The effects of x irradiation on the DNA content of developing cerebellum and cerebral cortex of rat brains was also studied. Preliminary results are reported. (C.H.)

49287 EFFECT OF X RAYS ON ENZYMES OF THE MOUSE TESTES. Kochar, Nirmal K.; Harrison, R. G. (Univ. of Liverpool). J. Anat.; 109: 39-50(May 1971).

The testes of mature male A_2G mice were exposed to a single dose of 1000 of x rays, and the mice killed at intervals up to 150 days after irradiation. Enzymes were studied in the testes of control and irradiated mice using histochemical techniques, and estimated quantitatively by a subjective double blind method. The main site of dehydrogenase enzymes (succinic, α glycerophosphate and lactate dehydrogenase) was in the interstitial tissue. They were also present in the sperm region and the germ cell region. After x irradiation their concentration and distribution changed in a similar pattern. One day after irradiation there was a reduction of all the enzymes in the interstitial tissue. Having regained control level, the enzyme activity eventually leveled off below this value. Acid phosphatase activity was found in most cells. Up to 107 days after irradiation there was an increase of the enzyme in the interstitial tissue and at 150 days it approximated to the control value. Alkaline phosphatase was most conspicuous in the membrana propria, which thickened appreciably after irradiation, so that adjoining tubules were often in contact. β glucuronidase was present throughout all the tubules but no individual cell-types could be recognized; after 30 days, it was nearly absent from tubules but present in the interstitial tissue, though at 76 and 135 days slight activity in the tubules recurred. The significance of histochemical alterations in the interstitial tissue occurring simultaneously with tubular changes is discussed. (UK)

49288 CHANGES IN THE DIURNAL RHYTHM OF NEUROSECRETORY ACTIVITY IN THE MOUSE FOLLOWING X-RAY IRRADIATION. Lach, H. (Teacher Training Coll., Krakow); Srebro, Z. Folia Biol. (Krakow); 19: No. 2, 289-97(1971).

The amount of stainable neurosecretory material was estimated densitometrically in the supraoptic nucleus, paraventricular nucleus, and neural lobe during the diurnal secretory rhythm of 50 adult normal albino mice and in a comparable group of 50 animals following a single whole-body 3000 R irradiation (50 kV, 20 mA). Irradiation was performed at 11 hrs. The control and experimental animals were killed at 12, 18, 24, 6, and 12 hrs. In the normal control animals the amount of neurosecretory material in the neurosecretory centers and in the neural lobe shows a distinct diurnal rhythm, the largest amounts being found at 18 hrs. In the neurosecretory centers the lowest amounts occur at 12 hr and in the neural lobe at 24 hrs. Irradiation caused a considerable change in the secretory diurnal rhythm: a decrease in the amount of the neurosecretory material was observed in the neurosecretory centers, together with a shift of the maxima and minima. In the irradiated animals the lowest values in the supraoptic and paraventricular nuclei were observed at 24 hrs, i.e. 13 hrs post irradiation. The neural lobe of the irradiated animals, to the contrary, showed more neurosecretory material than in the controls. The differences between the irradiated and control animals, both in the neurosecretory centers and in the neural lobe, were statistically significant. (auth)

49289 IRRADIATION OF THE G. I. TRACT: COMPENSATORY RESPONSE OF STOMACH, JEJUNUM, AND COLON. Hagemann, Ronald F.; Lesher, S. (Allegheny General Hospital, Pittsburgh). Brit. J. Radiol.; 44: No. 524, 599-602(Aug 1971).

Proliferative cellularity in the stomach, jejunum and colon was measured following irradiation with 200, 500 and 1,000 R. A depression in cellularity was observed in all three tissues reaching a nadir about 24 hours after exposure. This was followed, in the jejunum and colon, by an exposure-dependent overshoot in cell proliferation which reached a peak at three to four days in the former and five days in the latter. In contrast, no appreciable overshoot in cell proliferation in the stomach was observed. At 24 hours after irradiation, an unusual dose-effect relationship for cellularity was noted, which, with the compensatory responses described, may have radiotherapeutic implications. (auth)

49290 CHANGES IN VISUAL ACUITY AND DISCRIMINATION LEARNING AFTER PROTON IRRADIATION OF THE STRIATE VISUAL AREA IN THE SQUIRREL MONKEY. Bose, Harry Edward. De Kalb, Ill.; Northern Illinois Univ. (1971). 85p. University Microfilms Order No. 71-18,542. Thesis.

In the primate species, the striate and prestriate areas of the neocortex play critical roles in visual discrimination learning and the degree of visual acuity as indicated by the minimum separable acuity threshold. The visual acuity of man and other diurnal primates has been associated anatomically with a point-to-point topographic, binocular representation of images from specific macular receptor fields of the retina of discrete regions of the lateral geniculates and the calcarine sulcus of the visual cortex. Earlier studies of the localization of visual functions in the striate cortex have relied primarily on ablation techniques with rats and cats for examining the topographic organization of the visual system. The aims of the present study were to examine changes in visual acuity in a representative primate species, the squirrel monkey, after precise proton stimulation of the striate visual area 17. Cyclotron accelerated protons were directed to the striate cortex of adult squirrel monkeys to determine the effects of high energy irradiation on visual acuity and on changes in the chemistry and cellular morphology in the stimulated region. The 22 MeV proton beam at dose levels of 10k or 20k rads was directed through a 10 mm circular aperture to the striate visual cortex, along the calcarine sulcus, to a depth of 5 mm from the skull. The monkeys were tested postoperatively for visual acuity using a noncorrection training procedure and a modified methods of limits. After the minimum separable visual acuity threshold had been determined for each subject, all of the monkeys were decapitated, and striate area 17 was removed for biochemical and morphological evaluations. It was concluded that the primary affect of proton stimulation of the striate visual area was a reduction in the minimum separable visual acuity threshold rather than impairments of visual discrimination learning or motor performance. This was interpreted to be consistent with the point-to-point projection system hypothesis. Furthermore, it was inferred that proton stimulation of the striate visual area resulted in changes in synaptic activity or transmission properties of neurons rather than changes in major cytoarchitectural characteristics of the stimulated tissue. It is apparent that proton stimulation of the cortex can be used as another approach for studying changes in such unique functions as acuity and learning and in studying specific chemical, cellular, and subcellular elements in specific regions of the cortex. (Diss. Abstr.)

49291 EFFECT OF THE ABDOMEN AND HEAD SHIELDING DURING GAMMA IRRADIATION OF DOGS ON THE CONTENT OF PROTEIN FRACTIONS IN THE BLOOD SERUM. Davydov, B. I.; Syzrantsev, Yu. K.; Razgovorov, B. L. Kosm. Biol. Med.; 5: No. 3, 27-30(May-Jun 1971). (In Russian).

Dogs were exposed to gamma irradiation with a dose of 600 R local shielding of the abdomen (behind-the-shield doses of 150 and 300 R) and the head (behind-the-shield dose of 150 R) being applied. Protein fractions in the blood serum were determined by paper electrophoresis. The studies demonstrated a reduction of the albumin-globulin coefficient regardless of the shielding location; an increase of β-globulins whose level returned to the normal by the 100th day when the abdominal region was shielded and the residual dose behind the shielding was 150 R; an increase of the α/γ-globulin coefficient mainly on the account of the α_2-fraction. The globulin increase correlated with an increase of glutamate aspartate transferases. (auth)

49292 EFFECT OF POLYCYTHEMIA ON THE HEMATOPOIETIC REGENERATION IN MICE IRRADIATED WITH SUBLETHAL DOSES. Schmitz, A.; Haot, J. (Univ., Liege). Compt. Rend. Soc. Biol.; 164: No. 8-9. 1862-5(1970). (In French).

Two series of females Swiss mice were irradiated with a dose of 400 R. Some of them were made polycythemic by daily injections of red corpuscles, during the two consecutive days after irradiation and, then, after the third day, every three days, in order to retain polycythemia. Polycythemia is found to inhibit the regeneration of the erythroid population. On the contrary, it does not modify the recovery of small lymphoid cells appearing after a sub-lethal irradiation of the bone-marrow. (France)

49293 VARIATIONS IN THE CELLULAR POPULATIONS OF THE HEMATOPOIETIC BONE-MARROW AFTER TWO CONSECUTIVE IRRADIATIONS WITH A 500 R DOSE. Haot, J.; Barakina, N. F. (Univ., Liege). Compt. Rend. Soc. Biol.; 164: No. 8-9, 1859-62(1970). (In French).

The behavior of the hematopoietic system of two series of mice irradiated with one or two successive doses of 500 R was studied. The regeneration of the myeloid cells was found to increase with the second x-ray dose. Significant variations in the behavior of the lymphoid population were observed; the accumulation of lymphoid cells, characteristic of cell regeneration with a single x-ray dose, was not observed. (France)

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49294 CYCLIC 3'-5'-ADENOSINE MONOPHOSPHATE: ITS POSSIBLE ROLE IN MAMMALIAN CELL MITOSIS AND RADIATION-INDUCED MITOTIC G_2 DELAY. Scaife, J. F. (EURATOM, Varse, Italy). Int. J. Radiat. Biol.; 19: 191-5(1971).

Experiments were conducted to find the effect of a number of known inhibitors of cyclic 3'-5'-adenosine monophosphate (c-AMP) phosphodiesterase and of adenyl cyclase, pyridoxyl-5-phosphate, and imidazole, on the mitosis of normal and x-irradiated (150 R) human kidney T-cells. Caffeine promoted cell division in unirradiated cells and reduced mitotic G_2 delay. Equimolar concentrations of theobromine and theophylline were less effective, but equally effective whether given before or after irradiation. Papaverine was still cytotoxic at 0.02mM; imipramine, pertoflan, chlorimipramine, and chlorpromazine were cytotoxic but showed a positive effect at 0.01mM. The following compounds were ineffective on cells: adrenaline, noradrenaline, triiodothyronine, glucose, and xanthine, as were 10^{-2}mM c-AMP and dibutyryl c-AMP. The effect of caffeine on the mitotic delay of x-irradiated (100 R) rat thymocytes was evaluated in vivo and in vitro. During the experiments on cultures of T-cells, near the mitotic peak, temporary formation of intracellular cytoplasmic bridges was observed between cells in close proximity. (UK)

49295 EFFECT OF X RAYS ON CIRCULATING LYMPHOCYTES OF MICE QUANTITATED BY PHYTOHAEMAGGLUTININ (PHA) RESPONSIVENESS. Doenhoff, M. J. (Royal Cancer Hospital, London). Clin. Exp. Immunol.; 8: No. 4, 603-15(Apr 1971).

Irradiation following adult thymectomy results in a reduction of the size of the T-cell pool of mice as adjudged by the number of blood cells which are found responding to PHA. Recovery of the number of cells in the pool does not occur on a large scale over a period of 70 days in the absence of thymus tissue. (auth)

49296 DISRUPTION OF A RADIATION-INDUCED PREFERENCE SHIFT BY HIPPOCAMPAL LESIONS. Miller, C. R.; Elkins, R. L.; Peacock, L. J. (Univ. of Georgia, Athens). Physiol. Behav.; 6: No. 4, 283-5(Apr 1971).

Male rats with extensive hippocampal lesions, in contrast to control rats, continued to exhibit a strong preference for a saccharin solution after saccharin ingestion was paired with exposure to low level x irradiation. The results suggest that the hippocampus mediates, in part, the motivational consequences of exposure to x radiation. (auth)

49297 KINETICS OF CELL POPULATIONS OF TWO GENOTYPES IN XENOGENIC RADIATION CHIMAERAS. Zaretskaya, Yu. M.; Kovalchuk, L. V.; Strashnenko, S. I. (Inst. of Transplantation of Organs and Tissue, Moscow. Inst. of Biophysics, Moscow). Cytobios; 3: No. 12, 239-44(Apr 1971).

CBA mice lethally irradiated with a dose of 1000 r from a ^{60}Co γ ray source (610 r/min) were protected with Wistar rat bone marrow and for 100 days the quantitative kinetics of the main haemopoietic cell lines was studied by various methods of chimaeric identification. In the kinetics of the erythroid population, a sharp decline in the number of recipient erythrocytes was noted at first (0–60 days). After a period of stabilization (60–100 days) there was an active proliferation of the host erythroid elements. The granuloid population in chimaeras for the first month was derived from the donor, then the host elements were increasing and by the 100th day granulopoiesis was almost completely of murine origin. In the kinetics of the chimaeric lymphoid population, quantitatively extremely low, two variants of development were observed with predominance of either rat or mouse lymphocytes at the end of the second postradiation month. (auth)

49298 PARTIAL REGENERATION OF THE ULTRASTRUCTURE OF NEUROSECRETORY CELLS AFTER WHOLE-BODY GAMMA IRRADIATION. Voitkevic, A. A.; Dedov, I. I. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiol.-Radiother.; 12: No. 1, 131-43(1971). (In German).

The regeneration of the ultrastructure of neurosecretory cells of the nucleus superaopticus was examined with rats being irradiated by a dose of 800 R with a dose rate of 77 R/s. The GOLGI complex can only be normalized up to the level of small vesicles whereas large vesicles are lacking. In neutron-cytoplasm a fine endoplasmatic reticulum is newly formed. The completion of cytoplasmic membranes by polysomes leads to the formation of ergastoplasmic channels. The complete regeneration of all structures of the different organoids was not observed. Neurons of the surviving animals regenerate the ability to biosynthesis of the elemental neurosecretion granulae. Less differentiated elements, cells of the glia and of the endothelium of capillaries keep the ability for mitotic and amitotic division. (auth)

49299 HISTOLOGICAL AND HISTOCHEMICAL OBSERVATIONS ON THE KIDNEYS OF RATS AFTER LOCAL AND WHOLE BODY IRRADIATION. Unger, E. (Frederic Joliot-Curie Staatliches Forschungsinstitut fuer Strahlenbiologie und Strahlenhygiene, Budapest). Radiobiol.-Radiother.; 12: No. 1, 117-30 (1971). (In German).

The microscopic morphological changes in the kidneys of rats were studied by various histological and histochemical methods, and at different dates after 2000 to 8000 R local and 400 to 1000 R whole-body x irradiation. On the whole, the observable early changes were slight and seemed to confirm the relative morphological radiation resistance of the kidneys. (auth)

49300 EFFECTS OF X-IRRADIATION ON THE GENETICALLY-DETERMINED MELANOMA SYSTEM OF XIPHOPHORIN FISH. Pursglove, D. L.; Anders, A.; Doell, G.; Anders, F. (Justus-Liebig Univ., Giessen, Ger.). Experientia; 27: No. 6, 695-7(15 Jun 1971).

Embryos and germ cells of certain xiphophorin fish representing a genotype in which macromelanophore production was limited to small spots were exposed to x radiation. Irradiation produced pre-melanoma in the growing animals as well as in their offspring. No such radiation effect was observed in another group of the same fish in which the genotype caused macromelanophore production to such a degree as to produce melanomas later in life. If adults of this genotype were irradiated, tumor growth was briefly interrupted. (tr-auth)

49301 EFFECT OF IRRADIATION ON CELLS. PART II. Hajdukovic, S. (Inst. of Nuclear Sciences, Belgrade); Szirma, E. J. Inst. Nucl. Eng.; 12: No. 4, 107-11(Jul-Aug 1971).

The rupture of chromosomes is one of the most frequent injuries induced by irradiation and it is probable that this injury takes place at the moment of irradiation. Radiolesion takes place during the irradiation and is only manifested in the mitotic cycle. The different effects upon chromosome material caused by electromagnetic rays and by corpuscular irradiation are discussed. Under the effect of ionizing radiation the normal constant ratio between nucleus and cytoplasm volume is upset, the increased volume of cytoplasm producing giant cells. The effect of irradiation on the nucleolus and the parameters effecting radiosensitivity are considered. Two experiments are described to demonstrate the direct relationship between radiation injury and metabolic processes. In the first a study was made of the developing radiation injury as a function of the degree of maturity of the embryonic cells of hen eggs. Secondly an experiment with rats demonstrated abnormalities observed in the F_1 generation after whole-body irradiation of the male as well as by the simultaneous irradiation of the head and genital region but not under the local irradiation of the genital region. These results are discussed. (UK)

49302 TRANSPLANTATION OF RADIATION INDUCED CANINE MYELOMONOCYTIC LEUKAEMIA. Shifrine, M.; Bulgin, Marie S.; Dollarhide, Nancy E.; (and others) (Univ. of California, Davis). Nature (London); 232: No. 5310, 405-6(6 Aug 1971).

Some canine studies are described that show promise for studies of certain aspects of the pathogenesis of this disease, and in particular dynamic studies of changes in the haematopoietic system with time. Beagles continuously exposed to high ^{90}Sr concentrations developed a myeloproliferative syndrome, and some developed myelomonocytic leukemia. Cells from the latter were transplanted to the fetuses of pregnant beagles. Abnormalities were observed in pups 8 to 71 days after birth, and closely resembled those in the original donor dog, although more pronounced. Details are given of the observed abnormalities. The feasibility of using the dog as a model for the study of myelogenous leukemia is claimed to have been demonstrated; previous studies were with mice. (UK)

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Refer also to abstracts 49078, 49127, 49149, 49168, 49195, 49197, 49253, 49256, and 49263.

49303 (CEX-71.1) THE NATURE OF THE PROBLEMS INVOLVED IN ESTIMATING THE IMMEDIATE CASUALTIES FROM NUCLEAR EXPLOSIONS. White, Clayton S. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Mar 1971. Contract AT(29-2)-1013. 49p. Dep. NTIS.

It was pointed out that considerable progress has been made in assembling range-yield-effects data for nuclear detonations applicable to a variety of burst conditions and that tentative though incomplete biomedical criteria have been formulated for assessing the hazards of exposure to blast as well as ionizing and thermal radiations. Even so, it was noted that great care must be taken if meaningful concepts are to come from a combined use of the physical and biomedical data. In emphasis of this fact, the physically and biologically oriented problem areas were presented and discussed. Also, survival data for the Hiroshima explosion were

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used to show that the conditions of exposure more than any other factors determined immediate survival and more than anything else were responsible for keeping the casualty figures as low as they were. A major deterrent in applying the experience in Japan to a more generalized situation is the lack of information about the differences between "free-field" parameters and the environmental variations that will actually occur at the locations of people immediately following the burst. The relevant problems are complex and difficult and there has been neither widespread appreciation of the need to "move out of the streets and into exposure locations" nor with one exception much progress in translating "free-field dose" to "exposure dose" at locations of interest. The exception is the Ichiban I Program being carried out cooperatively by personnel from Oak Ridge National Laboratory and the Atomic Bomb Casualty Commission. A second difficulty in generalizing across the range-yield spectrum of effects is the fact that, all other things being the same, the ratios of the major effects parameters to one another change with yield; viz., the range-yield-effects curves for thermal and ionizing radiation and for blast are not parallel with one another. Even so, tentative biomedical criteria can be combined with range-effects data for different yields and burst conditions to define the ranges inside which and the areas over which specified potential hazards exist. Also, given a completely flat terrain, the absence of structures, and all people exposed in the open, casualty estimates for such "free-field" exposure conditions might perhaps be credible. In the presence of terrain variations and the many types of buildings in cities and urban complexes, there can be no satisfactory predictions until positional, geometric, and orientational factors along with others defining the conditions of exposure have been recognized and assessed. The state of the art currently does not include this sophistication and any but the grossest estimation of nuclear casualties is hardly possible today. (auth)

49304 (CONF-710324-1) ASSESSMENT OF RADIATION DAMAGE IN LYMPHOCYTES FOLLOWING RADIOPHOSPHORUS TREATMENT IN VIVO. Ilbery, P. L. T.; Chee, C. A.; Rickinson, A. B. [nd]. 8p. Dep. NTIS (U. S. Sales Only).

From third human cytogenetic conference; Sydney, Australia (16 Mar 1971).

The early results of a survey of radiation damage sustained by the peripheral blood lymphocytes of polycythaemia rubra vera and haemorrhagic thrombocythaemia patients receiving radiophosphorus treatment are presented. Short-term lymphocyte cultures were set up immediately before the beginning of treatment, and continued at regular intervals thereafter over a period of several months. The incidence of chromosome aberrations was determined on each occasion in order to attempt correlation with the dose of radiation received. An alternative approach to the assessment of radiation damage has been developed, based upon changes in the growth kinetics of short-term lymphocyte cultures from the irradiated patient. The experimental procedure is described, and its possible application to the present survey is discussed in the light of preliminary results. It is hoped that this combination of cytogenetic and kinetic information will provide a broader picture of radiation-induced lymphocyte damage, covering both its structural and functional aspects. (auth)

49305 (CONF-710324-2) CHROMOSOME ABERRATIONS IN LYMPHOCYTES FROM PATIENTS EXPOSED TO THORIUM DIOXIDE. Woodliff, H. J. (Royal Perth Hospital (Australia)); Cohen, G.; Gallon, W. [1970]. 10p. Dep. NTIS (U. S. Sales Only).

From third human cytogenetic conference; Sydney, Australia (16 Mar 1971).

The results of peripheral blood leukocyte cultures of two patients who were previously injected with Thorotrast are given. In both cases, metaphases were found containing dicentrics, acentric fragments, rings, and marker chromosomes. In one case, tricentrics were found. The literature is reviewed and the significance of the findings is discussed. (E.R.B.)

49306 (NP-18907) RADIOBIOLOGY OF THE LYMPHOCYTES. Girard, Jean-Francois; Pompidou, Alain (Centre de Recherches du Service de Sante des Armees, Percy (France). Division de Radiobiologie Experimentale). Nov 1970. 37p. (In French). Dep. NTIS (U. S. Sales Only).

The lymphocyte is a special blood cell, very different from the others, and radiobiology should provide a more accurate knowledge of its physiopathology. Whole-body irradiation methods are used for this study, either tissular or extra-corporeal, the latter being the most generally employed since it enables large doses to be delivered to the blood. More complete information has thus been obtained concerning the distribution and circulation of lymphocytes inside a given organism, leading to a more rational use of radiations in experimental pathology and in human pathology and therapy. It will thus be possible to decide whether irradiation is indicated with or without other therapeutic means (immunosuppressives, antilymphocyte serum, immunity additives) and to judge in which order these methods should be used for greater efficiency. (France)

49307 CHRONIC HAZARDS OF IONIZING RADIATION. Jovicic, B. Med. Glas.; 22: No. 5, 125-8(May 1968). (In Serbo-Croation).

The sources of ionizing radiation to which people are exposed include the naturally occurring radioactive elements, fallout, cosmic rays, radioisotopes used in industry and in medical diagnostics, etc. The effects of this ionizing radiation are both somatic and genetic, and with continual exposure, are cumulative. The well-known changes in the hematopoietic system, which are both qualitative and quantitative and depend on the dose and on the type of radiation, are described along with side effects. (TTT)

49308 SOURCES OF TRITIUM AND ITS HEALTH PHYSICS PROBLEMS. Carach, Jozef; Cechvala, Lubomir. Proc. Lek.; 120-5(May 1971). (In Slovak).

The literature (35 references, mostly English or Western European) on sources and health hazards is reviewed with respect to both naturally occurring and artificially produced tritium, its effects on biological material (tissue, etc.) and maximum permissible doses, production of tritium in heavy-water reactors, monitoring and control of tritium, including methods for measuring amounts present, methods for protection from this nuclide, and decontamination of contaminated surfaces. (TTT)

49309 INTERESTING CASE FROM THE POINT OF CARDIAC AND PULMONARY MOVEMENT, ESPECIALLY PULMONARY FUNCTION. 2. A CASE OF ESOPHAGEAL NEOPLASMS WHERE DYSPNEA OCCURRED BECAUSE OF ADVANCED PULMONARY ESOPHYSEMA AFTER RADIOTHERAPY. Kanagami, Haruo; Yoneyama, Takeshi; Baba, Kensuke; Nagashima, Teruya (National Cancer Center, Tokyo). Nippon Kyobu Rinsho; 29: No. 5, 349-54(May 1970). (In Japanese).

A total dose of 4500 R of linear radiation was administered to esophageal neoplasms that showed very slight cystic pulmonary emphysema on thoracic radiography and pulmonary function tests. As a result, advanced radiation fibrosis of the lung in the middle lobe and advanced pulmonary emphysema due to fibrosis were found. Therefore, this case was studied. A positive correlation was noticed between the radiation doses and the frequency of occurrence of radiation injuries of the lung. So radiation fibrosis of the lung was estimated by the total radiation doses. The first influence of radiation fibrosis of the lung on pulmonary function was diffusion disorder. In addition, a high degree of disproportion of distribution of blood flow in the lower lobe of both the lungs was seen and especially reversion of ventilation and blood flow distributions in the middle and lower lobes of the left lung showed cause of anoxemia. The reversion of distributions of ventilation and blood flows and the occurrence of pulmonary emphysema could not be predicted from preoperative findings of pulmonary function studies and roentgenograms. However, it was suggested that during the period of radiotherapy in old men, the occurrence of pulmonary emphysema should be carefully observed. (Japan)

49310 RADIOSENSITIVITY TEST IN THE CASE OF CERVIX UTERUS CANCER. Kasamatsu, Tatsuhiro (National Cancer Center, Tokyo). Sanfujinka No Sekai; 22: No. 5, 504-8(May 1970). (In Japanese).

Radiosensitivity tests are performed to estimate the effect of x-ray therapy on cancer of the cervix uteri. In the morphological method; with palpation, reduction in tumoral lesion of the uterus over the paracolpium serves as an indication of the radiosensitivity; and with plain inspection, clinical improvement of the erosive lesion of the neoplastic ulcer in the primary lesion and the improvement of filtration in the vaginal wall served as the indicators. The changes due to x irradiation are generally manifested with 3000 R doses and in some other cases they do not arise even with 5000 R. The former is known as "sensitive" and the latter as "insensitive". In histological examinations, the radiosensitivity is high in the tissues with many interstitial blood vessels and with weak proliferation of reactive phorocyte according to the findings prior to the radiotherapy. That is, the radiosensitivity is affected not only by neoplastic cells but also by the surrounding tissues. The findings after x irradiation could be classified into two groups, i.e., cases where neoplastic cells were affected by x irradiation and cases where the cells unaffected by x rays remain. A marked difference was indicated in the recovery rate between these two groups. In the vaginal smear method, the vacuolar degeneration of the cytoplasm served as the indication of the changes due to radiotherapy, and these changes were found to be closely associated with the prognosis of the cases. In a functional method, observing the distribution of DNA,

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high radiosensitivity was found in the cases of cancer including the cells of high polyploid histologically. Thymidine, cytidine, and uridine were labeled with ^{3}H, and the changes in the labeling rate caused by an increase of the radiation were taken as an indicator. Following up the changes in ^{32}P-intake of neoplastic cells, it was assumed that the radiosensitivity is high in the high uptake rate cases and the cases where ^{32}P-intake is markedly reduced by the irradiation. It was also noted that the radiosensitivity is increased in the area with a high oxygen concentration. (Japan)

49311 GASTRIC CARCINOMA IN A FIXED POPULATION. HIROSHIMA AND NAGASAKI. Yamamoto, Tsutomu (Atomic Bomb Casualty Commission, Hiroshima); Kato, Hiroo; Ishida, Kenzo; McGregor, D. H.; Tahara, Eiichi. Gann; 61: No. 5, 473-83(Oct 1970).

Gastric carcinoma was present in 326 of 2,908 cases of autopsy performed during 1961 to 1968 on the fixed population (ST-100) of Hiroshima and Nagasaki. The prevalence rate of gastric carcinoma was 11.7% in Hiroshima and 9.8% in Nagasaki. The findings obtained with regard to prevalence by sex, age, gross classification, histological classification, infiltration in the gastric wall, and metastasis to other organs and lymph nodes were similar to those reported in literature. In general, no relationship was observed between prevalence rate of gastric carcinoma and radiation exposure, but some findings were suggestive of such a relationship. In Hiroshima and Nagasaki males autopsied during 1961 to 1964, the tubular medullary histological type was found more frequently in the irradiated than in the control group. A suggestive relationship was also observed between exposure dose and the prevalence of histologically scirrhous type in Hiroshima males autopsied during 1965 to 1968. No difference was noted between the group exposed to 40 rads or more and the group exposed to less than 40 rads with regard to gross findings, size of tumor, infiltration of gastric wall, or metastasis to other organs and lymph nodes. These findings suggest the desirability of conducting a long-range follow-up study to accumulate a large number of cases and to determine whether these relationships are true or chance findings. (auth)

49312 HERPES ZOSTER INDUCED BY X AND COBALT IRRADIATION. Kelemen, Zsigmond; Halmy, Klara. Borgyogy. Venerol. Szemle; 45: No. 5, 213-9(1969). (In Hungarian).

Induction of herpes zoster by ionizing radiation is discussed. Pathophysiological processes occurring during the latent period are analyzed. Reviewed are 103 cases of herpes zoster following x radiation. Additionally case histories are reported for six patients, three of whom received ^{60}Co γ radiation alone, while the other three received a combination of γ and x radiation. (H.B.G.)

49313 LOW PROBABILITY OF ALLERGIC REACTION TO ALBUMIN MICROSPHERES. Rhodes, Buck A. (Johns Hopkins Medical Institutions, Baltimore). J. Nucl. Med.; 12: No. 9, 649-50(Sep 1971).

The following sources of data were examined for determining the probability that an intravenous injection of a scanning dose of albumin microspheres would produce a severe allergic reaction in man: data on reactions of patients to intravenous injections of various types of denatured human albumin labeled with ^{131}I or ^{99m}Tc; data on reactions of animals to injections of various types of denatured serum albumin; and data on reactions of patients receiving serial injections of human serum albumin microspheres. The evidence suggests that there is a low probability of a serious allergic reaction of patients to injections of human serum albumin microspheres. (H.L.W.)

49314 COSMIC RAY FLASHES IN THE EYE. McAulay, I. R. (Trinity Coll., Dublin). Nature (London); 232: No. 5310, 421-2(6 Aug 1971).

Experimental work is described leading to the conclusion that the observation by Apollo astronauts of light flashes in the eye can be interpreted as scintillations produced in the eye lens by the passage of multiply charged cosmic rays. It was found that scintillations are produced by 5.3 MeV α particles in eye lenses from freshly killed bullocks, and the higher specific ionization produced by nuclei in primary cosmic radiation should produce much larger scintillations. The necessity of postulating some focusing mechanism for the light to account for the reported point flashes is discussed. Scintillations large enough to be visible will be produced only by particles of high charge and relatively low energies (<1 GeV). The use of contact lenses, silvered on the front surface, should considerably increase the number of visible flashes. (UK)

Radiation Effects on Plants

Refer also to abstracts 49080, 49120, 49152–49154, 49156, 49158, 49160, 49166, and 49319.

49315 COMBINED EFFECTS OF VIBRATION AND GAMMA RADIATION ON CHLORELLA. Anikeeva, I. D.; Moskvitin, E. V. Kosm. Biol. Med.; 5: No. 3, 85-7(May-Jun 1971). (In Russian).

A study was made of the combined effects of mechanical vibration and γ rays on the single-celled green alga Chlorella vulgaris. Suspensions of the alga were subjected to different combinations of vibration and radiation; the vibration cycle consisted of 100 hz for 15 min at an amplitude of 2 mm, and the radiation dose was 200 R. As judged from the subsequent growth behavior, no significant difference from the control sample was manifest. Survival of the cells was improved by a short burst of radiation, but decreased after longer dosage. The frequency of appearance of mutations was slightly higher for all combinations of vibration and radiation than for the controls. (K.S.W.)

49316 PHOTORECOVERY OF GAMMA IRRADIATED CULTURES OF BLUE-GREEN ALGA, ANACYSTIS NIDULANS. Asato, Y. (Ames Research Center, Moffett Field, Calif.). Radiat. Bot.; 11: No. 4, 313-16(Jul 1971).

Among procaryotes, blue-green algae tolerate very high doses of γ radiation. However, very little work has been done in demonstrating the modes of protection and/or repair. Evidence is presented for photorecovery after ^{60}Co γ irradiation. Survival curves showed higher levels of viable cells in cultures continuously exposed to white light than in those which were held in the dark for 24 hr. To demonstrate the post-irradiation effect of visible light, cultures irradiated with 35 krad were given pulsed exposures of 0–60 min of white or red light. Samples were held in the dark for 24 hr before plating. The data depicted increases of survivors within 30 min in white light but none in red light, but the mode of photorecovery could not be determined. (auth)

49317 EFFECTS OF γ RAYS APPLIED AT THE COMMENCEMENT AND TERMINATION OF THE RESTING STAGE ON TOBACCO ZYGOTES. Saccardo, F.; Devreux, M. (CNEN, Rome). Radiat. Bot.; 11: No. 4, 303-8(Jul 1971). (In French).

A total exposure of 4 kR of γ was applied with seven different exposure rates (83, 167, 333, 667, 1333, 2667 and 5333 R/hr) to the zygotes of tobacco during the resting stage. A first series of treatments started at midday the third day after pollination, while a second series of treatments ended at midday the fifth day after pollination; the times of exposure, according to the exposure rates, were 48, 24, 12, 6, 3, $1\frac{1}{2}$ hr and 45 min. The radiobiological parameters considered showed that irradiation, during the last part of the zygote resting stage, induced the highest decrease of embryo development. The exposure rate effect is also more drastic during this second zygote resting period, and with the two highest exposure rates, all the proembryos died before the 13th day after pollination. The histological analyses showed many abnormalities during the first stages of the embryogenesis. The mean weight of 100 seeds, the mean number of seedlings per capsule, the mean number of germinated seeds and the cotyledon abnormalities showed the same abnormal behavior as embryonic development. All the results showed a variation of the radiosensitivity during the resting period of the zygote: in Nicotiana tabacum, the higher radiation sensitivity was in the G_2 zygote stage as compared with the G_1. The radiation damage induced by the higher exposure rates was greater than those induced by the lower rates. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 49080, 49099, 49112, and 49167.

49318 (AD-717563) MODE OF RADIATION RESISTANCE OF CLOSTRIDIUM BOTULINUM SPORES. Final Report, April 1968–March 1970. Church, Brooks D.; Germaine, Gregory R.; Rowley, Durwood B. (North Star Research and Development Inst., Minneapolis, Minn.). Aug 1970. Contract DAAG17-68-C-0094. 65p. (USA-NLABS-TR-71-4-FL; FL-112). NTIS.

Work was conducted to delineate the mechanisms responsible for the extraordinary resistance of Clostridium botulinum spores to ionizing radiation as compared with vegetative cells. The findings indicate that the progression from the high resistance of spores to the sensitivity of vegetative cells proceeds in at least three discrete steps. Several biochemical events have been shown not to play a key role in the resistance and the state of hydration and configuration of DNA has emerged as a prime candidate to explain the changes in resistance. (auth)

49319 (AECL-3961) BIOLOGY AND HEALTH PHYSICS DIVISION PROGRESS REPORT, JANUARY 1–MARCH 31, 1971. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 50p. (PR-B-89). Dep. NTIS (U. S. Sales Only). AECL $1.50.

BETA SOURCES—monitoring in lake sediments, development of low-background automatic counter for
EUMYCOTA—Schizosaccharomyces pombe, radiation effects on normal and radiosensitive strains of, comparison of dark repair mechanisms for uv
GAMMA RADIATION—monitoring in lake sediments, use of high-resolution Ge(Li) detector and computer-based pulse analysis system for low level
HEALTH PHYSICS—instrumentation development at Chalk River during 1971
INSECTA—Dahlbominus sp., radiation effects on mutation frequency in, dose effect curves for chronic low-dose γ
NEUTRONS FAST—effects on reproductive capacity of male Rhodnius, RBE for
NUCLEIC ACID, DEOXYRIBO-, —radioinduced degradation of, repair of uv and x
NUCLEIC ACID, RIBO-, —content of animal cells, oligonucleotide analysis for comparison of
RADIATION—effects in combination with urethane on incidence of leukemia in rats, ionizing
RADIATION DETECTORS—development at Chalk River during 1971
RADIATION DOSIMETERS—development at Chalk River during 1971
RADIOACTIVITY—monitoring in environment surrounding Chalk River nuclear facility in Canada
SEWAGE—radiation processing of liquid, feasibility of γ
SPERM—radiation effects on trout, dose-effect relation for gross eye malformation in fry following low dose
ULTRAVIOLET RADIATION—effects on DNA in Escherichia coli, identification of biochemical system for repair of
X RADIATION—effects on man following repeated fluoroscopic exposure during therapy, investigation of possible carcinogenic (E.R.B.)

49320 (ORO-3596-16) PROGRESS REPORT, JUNE 1968–JUNE 1971. (Florida Univ., Gainesville. Radiation Biology Lab.). 14p. Dep. NTIS.

Investigations were conducted to study the biochemical nature of the lethal and mutagenic effects of various types of radiation on cellular systems. Studies on cell survival and excision repair were conducted using ultraviolet-irradiated Escherichia coli and Bacillus subtilis. Studies were continued on effects of uv and x radiation on chromosome replication and DNA synthesis in bacteria. The repair of uv damage to DNA in Bacillus subtilis was studied in relation to replication of genetic markers. Evidence for the compartmentalization of semiconservative DNA replication from repair synthesis in Bacillus subtilis was investigated. Bacteriophage φX174 was used for studies on the effects of temperature, oxygen, nitrogen, and MEA on γ-radioinduced strand breaks in DNA. (H.L.W.)

49321 EFFECT OF INCUBATION WITH BACTERIAL EXTRACT ON THE SURVIVAL OF X-IRRADIATED BACTERIA. Mukherjee, P.; Bhattacharjee, S. B. (Saha Inst. of Nuclear Physics, Calcutta). J. Gen. Microbiol.; 65: No. 3, 275-83 (Mar 1971).

X-irradiated Escherichia coli B, a filament-forming strain, showed improved survival of x-rays after treatment with its own extract, either in liquid or on solid media. Extract-promoted recovery was not shown by a non-filament-forming strain E. coli B_{s-1}. Liquid holding recovery of x-irradiated bacteria in the absence of extract was not observed. Most experiments were performed in liquid medium where the increased survival number depended on the incubation period and the extract concentration. In about 30 min. the increase reached a saturation value; the maximum number of surviving cells was obtained using a certain (optimal) concentration of extract which was then employed in all subsequent experiments. The activity of the extract was completely destroyed by heating at 52° for 40 min. No activity was detected in the DNA, RNA or ribosomal fractions of the extract. The soluble remainder, however, was fully active, suggesting that soluble protein was the active principle. (auth)

49322 POLYNUCLEOTIDE KINASE MUTANT OF BACTERIOPHAGE T4. Chan, Voon Loong; Ebisuzaki, Kaney (Univ. of Western Ontario, London). Mol. Gen. Genet.; 109: 162-8(11 Dec 1970).

The isolation and biological properties of two T4 phage mutants that are deficient in polynucleotide kinase are reported. The two mutants are wild type with respect to replication, genetic recombination, and DNA repair (as measured by sensitivity to uv irradiation, γ irradiation, and ^{32}P decay). The negative results suggest that the phage-induced enzyme is not a critical factor in DNA metabolism. (auth)

49323 MODIFICATIONS OF THE AEROBIC BUCCAL FLORA AFTER BUCCAL PHARYNGEAL RADIOTHERAPY. Llory, H.; Dammron, A.; Frank, R. M. (CNRS, Strasbourg). Arch. Oral Biol.; 16: No. 6, 617-30(Jun 1971). (In French).

A study of the aerobic flora of the saliva and the dental plaques was undertaken on patients with cervico-facial carcinomas, who were treated with cobalt-tele-therapy and whose salivary glands were irradiated. An increase in the proportions of cariogenic lactic bacteria (streptococci and loactobacilli) as well as a salivary pH acidification were observed at the end of the irradiation. Streptococcus salivarius disappeared from the saliva: this loss was compensated through growth of Strep. mitis. The corynebacteria and the Neisseria were strongly reduced. These changes of the flora persisted 1 to 4 yr after the treatment. In patients with carcinomas of the maxillary sinuses, whose salivary glands had not been irradiated, the aerobic oral flora was normal 2 yr after radiotherapy. A direct relation can therefore be stressed between the rampant caries, observed in patients with irradiated salivary glands, the degenerative lesions of these glands, the xerostomia and the changes of the aerobic oral flora. (auth)

49324 THEORETICAL EVALUATION OF COMBINED IRRADIATION AND THERMAL PROCESSES IN CYLINDRICAL CONTAINERS WITH GAMMA SOURCES. Purohit, K. S.; Manson, J. E.; Zahradnik, J. W. (Univ. of Massachusetts, Amherst). J. Food Sci.; 36: No. 5, 750-1(Jul-Aug 1971).

A digital computer technique is presented for studying combined effects of heat and radiation in food sterilization, using steam retorts and cylindrical gamma sources. Temperature and dose rate distributions in cylindrical containers are computed using numerical methods. Distributions due to preliminary treatments—survivor and degree of spore sensitization—are inputs to subsequent treatment. The heat-radiation sequence was studied using data available, which indicates no synergism. This additive combination served as control to demonstrate synergism for radiation-heat sequence. Synergy, as influenced by irradiation exposure time, source strength, thermal process time, and retort temperature was studied. (auth)

49325 GAMMA-RAY TREATMENT OF TASTES AND ODORS. Vajdic, Ann H. (Ontario Water Resources Commission, Toronto). J. Amer. Water Works Ass.; 63: No. 7, 459-61(Jul 1971).

Plant and animal growths can impart an objectionable, musty odor to water containing them. The practicality of gamma irradiation to raise the aesthetic standard of drinking water contaminated with an odorous compound produced by a species of actinomycete is discussed. (auth)

Radiosterilization and Radiopreservation

Refer also to abstracts 49108, 49113, 49201, 49273, 49275–49278, and 49324.

49326 (COO-1689-6) RADIATION PASTEURIZATION OF FRESH MEATS AND POULTRY. Annual Report, February 15, 1969–February 14, 1970. Urbain, Walter M.; Giddings, George G.; Ballantyne, William W. (Michigan State Univ., East Lansing. Dept. of Food Science). Jun 1971. Contract AT(11-1)-1689. 56p. Dep. NTIS.

The objective of work under the present year's contract was a continuation of efforts to develop the process of radiation pasteurization of fresh meats and poultry to permit centralized cutting of these products. An average flavor score of approximately 5 on a 9 point scale was secured with beef that was phosphate treated, irradiated, and stored at 38°F under vacuum for 18 or more days followed by storage in air for 3 or more days. Unstored, untreated beef flavor scores averaged approximately 6. While the meaning of the flavor difference in terms of acceptance of the stored beef by the public could not be ascertained, efforts to determine its nature and cause were a principal activity of this contract year. An off-flavor immediately after irradiation was observed in the phosphate-treated beef. This interaction between radiation and the added phosphate solution requires further study. Irradiation of beef in air at high dose rates (above .05 Krad/sec) can cause discoloration. This discoloration can be eliminated by use of lower dose rates or by irradiating in the absence of oxygen. Efforts were made to understand the action of phosphates in maintaining the normal red color of beef. Studies with meat indicated that the protective action is not simply the result of a pH change. Studies on the isolated meat pigment, however, indicated little effect on oxidation, regardless of pH. These findings suggest that phosphate may be influencing reducing enzymes in the meat, rather than acting directly on the pigment molecule. Indications

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of a loose association of phosphate with meat pigment were secured, but there was no evidence of specific chemical bonding. The observed protective action of the phosphates on fresh meat color remains unexplained. (auth)

49327 (EUR-4618) IDENTIFICATION OF IRRADIATED MEAT BY THIN-LAYER GEL CHROMATOGRAPHY AND SOLUBILITY STUDIES. Radola, B. J. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe (West Germany). Institut fuer Strahlentechnologie). 1 Dec 1970. 24p. Dep. NTIS (U. S. Sales Only). EUR F.Fr. 4.45.

In beef and pork irradiated with a dose of 1 and 5 Mrad a new radiation-induced, sarcoplasmic protein fraction was observed on thin-layer gel chromatography on Sephadex G-200. The radiation-induced fraction migrating ahead of all other sarcoplasmic protein fractions of untreated meat could be readily identified in the chromatographic pattern. The amount of the radiation-induced fraction increased with increasing dose. Following irradiation at −30°C a smaller amount of this fraction was found than at 0°C. Solubility studies based on stepwise extraction of a protein precipitate absorbed on an inert carrier with a series of ammonium sulphate solutions of decreasing molarity have shown that the fractions extracted with 1, 1.5 and 2 M ammonium sulphate are reduced in irradiated meat. The demonstration of a radiation-induced, sarcoplasmic protein fraction can serve as a basis for identification of meat irradiated with a dose of 5 Mrad. (auth)

49328 (NYO-3989-3) RESEARCH ON THE STERILIZATION WITH RADIATION FOR THE CONTROL OF THE "SOUTHAMERICAN FRUIT FLY" ANASTREPHA FRATERCULUS (WIED.). Progress Report, July 1969–September 1970. Gonzalez Bachini, Juan E. (Estacion Experimental Agricola de la Molina, Lima (Peru)). 30 Apr 1971. Contract AT(30-1)-3989. 48p. Dep. NTIS.

The possibility of using γ-irradiated males for the control of the South American fruit fly, Anastrepha fraterculus, using the sterile male technique is under investigation. Data are included from studies on the effects of doses of 4, 5, or 6 Kr γ radiation delivered to pupae on the sexual competitiveness of adult flies. Methods used for rearing flies in the laboratory are described. (C.H.)

49329 RADURIZATION TESTS OF VACUUM SLICED HAM IN CELLULOSIC OR PLASTIC BAGS. Billon, J. (Abattoirs de la Villette, Paris). Food Irradiat.; 11: No. 1-2, 4-9(Jul-Dec 1970). (In French).

Ionizing radiations were used in order to increase the preservation time of vacuum packed sliced ham in cellulosic or plastic bags. The choice of the radiation dose and experimental methods used is described. Irradiation of 250 krad means that ham can be conserved for a period of 8 months at a temperature of +3 deg C. (France)

49330 RADIOSTERILIZATION OF MEDICAL PRODUCTS. I. Uhlig, K. Isotopenpraxis; 7: No. 4, 117-23(Apr 1971). (In German).

Radiosterilization of medical products is reviewed from an international standpoint. Especially discussed are developments in USA, England, and Denmark with respect to the effects of ionizing radiation on microorganisms, selection of medical products suitable for radiosterilization, radiation effects on container material, radiation sources and installations, and national as well as international rules concerning commercial exchange of products. The survey showed that the most commonly used dose of 2.5 Mrad proves sufficiently safe. (H.G.B.)

49331 MILK PRESERVATION BY IONIZING RADIATIONS. Gerrard, Martha. Food Irradiat.; 11: No. 1-2, 21-31(Jul-Dec 1970). (In French).

The literature published on milk and dairy-produce irradiation indicates that its applications are not numerous. Cheese is an exception, as irradiation may be used to control the surface growth of mildew. The unnatural colors, odors, and tastes produced by irradiating milk render the method as yet impractical. (France)

49332 DISINFESTATION BY γ IRRADIATION OF DRIED FRUIT. Brower, John H.; Tilton, Elvin W. (Agricultural Research Service, Savannah, Ga.). Food Irradiat.; 11: No. 1-2, 10-14(Jul-Dec 1970). (In French).

Tests were made in order to control insect population by the γ irradiation of dried fruit. Dried grapes, red-currants, plums, and apricots were contaminated with the indian flour pyralis, Plodia interpunctella, or limenitis, Oryzaephilus surinamensis, and then irradiated. A 40 krad dose was found to inhibit insect growth and to protect this food. (auth)

49333 SOME PHYSICAL EFFECTS OF POSTHARVEST GAMMA RADIATION ON THE FRUIT OF SWEET CHERRY, BLUEBERRY, AND CRANBERRY. Eaton, G. W.; Meehan, C.; Turner, N. (Univ. of British Columbia, Vancouver). Can. Inst. Food Technol. J.; 3: No. 4, 152-6(Oct 1970).

Fruit samples from two cultivars of sweet cherry, six cultivars of highbush blueberry, and one cultivar of cranberry were irradiated with doses of 0 to 500 Krad in the case of cherry and blueberry and 0 to 1000 Krad in the case of cranberry. The treated cherries and blueberries were tested for changes in color, texture, and soluble solids over time, and the cranberries were evaluated in terms of average number of acceptable berries per sample over time. Analyses of variance were carried out on the results, and either Duncan's New Multiple Range test or the Least Significant Difference test was applied to means significantly different at the 5% level. Gamma radiation tended to increase cherry darkness, redness, and soluble solids content. At the highest dosage, yellowness was increased, and, in one cultivar, firmness was decreased. In some blueberry cultivars, some dosages increased darkness, and caused a shift in color from red towards green. Some dosages increased soluble solids in most cultivars and caused a softening of fruit in many cases. Considerable fruit injury to cranberry was caused by all dosages from 126 to 1000 Krad. However, radiation tended to eliminate normal mottling in berries by causing an even distribution of red skin pigment. In general, radiation as applied in this study does not appear to be particularly useful in maintaining the quality of these fruits. (auth)

49334 CANNED FOODS. AN INTRODUCTION TO THEIR MICROBIOLOGY. Hersom, A. C.; Hulland, E. D. [London]; J and A Churchill Ltd. (1969). 319p. £ 2.25.

One chapter on the use of ionizing radiations for food preservation is in NSA scope. The subject is dealt with under the headings: factors affecting radiation resistance; relative resistance of micro-organisms to ionizing radiations; and effects of ionizing radiation on food. (UK)

49335 CYTOTOXIC AND MUTAGENIC EFFECTS OF IRRADIATED SUBSTRATES AND FOOD MATERIAL. Kesavan, P. C.; Swaminathan, M. S. (Jawaharlal Nehru Univ., New Delhi. Indian Agricultural Research Inst., New Delhi). Radiat. Bot.; 11: No. 4, 253-81(Jul 1971).

The lethal effects of both ionizing and non-ionizing radiations have many potentially important applications in food technology. To capitalize on this use, a pre-requisite is the clear establishment of the absence of undesirable secondary effects in the irradiated material. Commencing from the study of Stone, Wyss and Haas (1947) who found that uv-irradiated substrate itself induces mutations in Staphylococcus aureus, numerous studies have been carried out to ascertain whether cytotoxic effects occur when unirradiated biological test systems are cultured or fed with irradiated media or food. In such studies, in a wide range of test systems, adverse physiological, cytological and genetical effects have been observed which are very small in frequency of occurrence compared to those observed when the test systems are exposed directly to radiation. Consequently, they can be demonstrated primarily by statistical comparisons with the control populations. The yield and longevity of the cytotoxic principle generated in irradiated media are dose-dependent but the genetic effects do not show any well defined relationship with dose and also vary even within the same test organism. Any glucose component seems particularly prone to the effects of radiation with reference to the production of cytotoxic and mutagenic secondary products. In some systems, the addition of catalase neutralized the cytotoxic effects, while in others it did not. Hydrogen peroxide probably plays an important intermediate role in the formation of various toxic derivatives. The available data suggest that hydrogen peroxide, glyoxal, formic acid, hydroxyalkyl peroxides, histidine-peroxide adduct and deoxycompounds may act as the toxic and mutagenic agents in different systems. Most data now available in this field relate to somatic effects. The genetic data gathered in Drosophila melanogaster are conflicting, while in E. coli there is conclusive evidence of the mutagenic effects of irradiated media. In order to understand fully the bearing of these findings on human nutrition, data from critical genetic experiments in mice are urgently needed. 169 references. (auth)

49336 EFFECTS OF IRRADIATION ON THE SENSORY QUALITY OF REFRIGERATED SMOKED WHITEFISH. Slusar, M.; Vaisey, M. (Univ. of Manitoba, Winnipeg). Can. Inst. Food Technol. J.; 3: No. 4, 162-6(Oct 1970).

Acceptability scores for irradiated hot-smoked whitefish (Coregonus clupeaformis) were significantly higher ($P < 0.01$) than those for unirradiated fish over 28 days' storage at 4°C. Scoring patterns showed the most marked differences immediately after irradiation and at 21 days' storage. Fish from a

single catch were smoked commercially, sampled, frozen, and withdrawn from −40°C storage at 28, 21, 14, 7, and 0 days before examination. Gamma irradiation was applied after thawing, immediately before refrigerated storage. The sensory evaluation was replicated three times. Scoring of acceptability, flavor, and texture by eight semi-trained judges using the multiple comparison difference test showed that flavor scores followed the same pattern as the acceptability scores. No effects of either irradiation or storage were apparent from texture scores. No differences in sensory qualities were found between fish irradiated at 0.3, 0.4, and 0.5 megarads. (auth)

49337 COLOR CHANGES IN RADIATION PASTEURIZED BEEF. Richards, J. F.; Morrison, B. C. (Univ. of British Columbia, Vancouver). Can. Inst. Food Technol. J.; 4: No. 1, 1-5(Jan 1971).

The effect of doses of gamma radiation varying from 0.1 to 1.5 Mrad applied to beef at 0°C on meat color was assessed by tristimulus colorimetry. Marked differences in redness and yellowness occurred among samples with the surface myoglobin in the reduced (Mb), oxygenated (MbO_2), or oxidized (Mb+) state. Irradiation of samples packaged in oxygen-permeable film (Vitafilm) resulted in a greater decrease in redness than irradiation of comparable samples packaged in oxygen-impermeable film (Saran). Samples packaged in Vitafilm and overwrapped in Saran prior to irradiation with 0.8 Mrad retained the ability to reoxygenate after as long as 8 days post-irradiation storage at 4.4°C before removal of the outer wrap. No significant differences ($P > 0.05$) in redness were noted among the unirradiated control samples at 0 days and samples from which the outer wrap was removed after 0, 2, 4, 6, or 8 days storage. The decrease in redness after removal of the outer wrap was not affected by time of storage. (auth)

49338 PRESERVATION OF FOODS BY IRRADIATION. IRRADIATION OF FISH PRODUCTS. de la Sierra Serrano, Daniel. Energ. Nucl. (Madrid); 14: No. 68, 483-93(Nov-Dec 1970). (In Spanish).

The progress made in the irradiation of products of marine origin, both international and domestic, is described. The principal results obtained in the United States, USSR, England, Canada, France, and other countries are summarized. The microbiological aspects of radiopreservation, especially with respect to Clostridium botulinico, type E, are considered in some detail. (J.S.R.)

49339 STERILIZATION OF AEDES AEGYPTI (L.) AS A RESULT OF CHRONIC EXPOSURE TO LOW DOSES OF BETA RADIATION. Guthrie, J. E. (Whiteshell Nuclear Research Establishment, Pinawa, Manitoba); Brust, R. A. Nature (London); 232: No. 5309, 345-6(30 Jul 1971).

Sterilization of more than 70% of the adults of laboratory populations of the mosquito Aedes aegypti was achieved by exposure to a total β-radiation dose of as little as 90R during the early larval stages, this dose being about one-tenth of the x-ray doses used to sterilize the pupal or adult stages. The newly hatched larvae were irradiated for 192 hours by rearing them in media containing 0.1, 1.0 and 10μCi ^{90}Sr in equilibrium with ^{90}Y. The use of sealed $^{90}Sr + ^{90}Y$ plaques placed in the rearing medium allowed calculation of the external dose delivered. Larvae reared in 10μCi/ml did not pupate, but those reared in 0.1 and 1.0 μCi/ml developed normally and the adults showed no gross morphological abnormalities, although development of the ovaries and testes was arrested. Data are tabulated on the effect of continuous β-irradiation of larvae on feeding and egg viability of adults. Females irradiated as larvae laid no eggs, and females in the 1.0 μCi/ml treatment groups took no blood. It is concluded that sterile females might be used in combination with sterile males to control mosquito populations. (UK)

49340 EFFECT OF RADURIZATION ON SHEAR RESISTANCE AND FRAGMENTATION OF CHICKEN MUSCLE. Whiting, R. C.; Richards, J. F. (Univ. of British Columbia, Vancouver). J. Food Sci.; 36: No. 5, 752-5(Jul-Aug 1971).

Excised pectoralis muscles of chicken received radurizing doses of γ radiation at varying times post-mortem to determine the effect on shear resistance, myofibrillar fragmentation (F-ratio), and pH. Irradiation doses between 0.1 and 0.3 Mrad produced decreases in F-ratio and increases in shear resistance. The magnitude of the changes was directly proportional to the duration of postmortem aging prior to irradiation. Muscle pH subsequent to irradiation between 2 and 12 hr post-mortem was not significantly affected by any of the dose-time treatment combinations. Shear resistance and F-ratio changes were strongly correlated on an average basis ($r = +.857$; $n = 6$) but not on an individual sample basis. (auth)

49341 IMPACT OF LOW DOSES OF GAMMA RADIATION AND STORAGE ON THE MICROFLORA OF GROUND RED MEAT. Tiwari, N. P.; Maxcy, R. B. (Univ. of Nebraska, Lincoln). J. Food. Sci.; 36: No. 5, 833-4(Jul-Aug 1971).

The effects of low doses of γ radiation (34 and 68 Krads) on the bacterial count of high-quality fresh ground beef during storage at different temperatures (2° and 5°C) were determined. The total bacterial count in the high-quality ground beef, before processing, was 1.1×10^6/g as compared to 3.5×10^7/g for the average of samples obtained from commercial retail stores. Unirradiated high-quality meat reached the point of unacceptability from a public health standpoint (5.0×10^7 to 1.0×10^8/g) in 5 days when stored at 5°C and in 6 days at 2°C. For the irradiated (68 Krads) high-quality meat to reach the point of unacceptability from a storage took 8 days at 5°C and 14 days at 2°C. The combination of irradiation (68 Krads) and storage at 2°C held the total bacterial count in the high-quality meat samples below the initial count of the best commercial samples for a period of 9 days. (E.R.B.)

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METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 48735 and 51030.

49342 (CONF-710315-25) DEVELOPMENTS IN HIGH-TEMPERATURE DESIGN CRITERIA. Slember, Richard (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). [1971]. 23p. Dep. NTIS.

From Conference on fast reactors; Palo Alto, Calif. (7 Mar 1971).

In the last two years considerable effort has been devoted to the development of more sophisticated design methods and criteria for use in elevated-temperature design. Stimulus for this effort has been largely a result of the needs of the Liquid Metal Fast Breeder Reactor program (LMFBR). Preparation of rational design rules has been limited by a lack of knowledge of material behavior and a general lack of analytical methods capable of predicting stresses and deformations in a complex structure under time-dependent loading conditions. The time-dependent failure modes upon which relevant elevated-temperature design rules must be based are discussed, and criteria being developed to preclude failure in these modes are reviewed. (auth)

49343 (ORNL-TM-3300) FUELS AND MATERIALS DEVELOPMENT PROGRAM QUARTERLY PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1970. Patriarca, P. (comp.) (Oak Ridge National Lab., Tenn.). Jul 1971. Contract W-7405-eng-26. 351p. Dep. NTIS.

Research progress is reported in twenty sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 48766, 48767, 49356–49358, 49371–49375, 49410, 49411, 49487, 49488, 49505–49507, and 49573–49575.

49344 (ORNL-TM-3416) FUELS AND MATERIALS DEVELOPMENT PROGRAM QUARTERLY PROGRESS REPORT FOR PERIOD ENDING MARCH 31, 1971. Patriarca, P. (Oak Ridge National Lab., Tenn.). Jul 1971. Contract W-7405-eng-26. 255p. Dep. NTIS.

Research progress is summarized in 19 sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 48768, 48769, 49359–49361, 49376–49381, 49412, 49489, 49508, 49509, and 49576–49579.

49345 (WASH-1181) METALLURGY AND MATERIALS PROGRAMS, Fiscal Year 1971. (Division of Research (AEC), Washington, D. C.). Jul 1971. 99p. Dep. NTIS.

A compilation and index of AEC programs is presented for use by administrators, managers, scientists, and others as an aid to research coordination and in selection of new programs. Information is included in sections on projects at laboratories and universities, funding levels, and an index. (J.R.D.)

49346 PRESSURE VESSEL ENGINEERING TECHNOLOGY. Nichols, R. W. (ed.). New York; American Elsevier Publishing Company, Inc. (1971). 618p. $38.50.

Information and discussions on various aspects of pressure vessel engineering are presented. The material is presented in chapters on design of conventional pressure vessels, fatigue effects, combined effects of creep and fatigue, brittle fracture, materials selection, fabrication, inspection, high pressure vessels, and faults and failures. A separate abstract was prepared for the single remaining chapter on vessels for special purposes. (J.R.D.)

For an abstract of an individual chapter see: 49493.

Corrosion and Erosion

Refer also to abstracts 48691, 48697, 48736, 48738, 50266, and 51071.

49347 (ANL-Trans-889) SECE-GECA STUDY OF THE CORROSION PROPERTIES OF STEELS AND IRON-CHROME-NICKEL ALLOYS. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Argonne National Lab., Ill, from Section 5.1, pp 130-44 of report CEA-N-1341. 14p. Dep. NTIS.

An abstract of this paper, prepared from the original language, is included in NSA 25: 6830.

49348 (ANL-Trans-890) SECE-SECMLG STUDY OF THE COMPATIBILITY OF FERRITIC STEELS WITH CIRCULATING LIQUID SODIUM. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Argonne National Lab., Ill., from Section 5.13, pp 206-15 of report CEA-N-1341. 10p. Dep. NTIS.

An abstract of this paper, prepared from the original language, is included in NSA 25: 6830.

49349 (ANL-Trans-893) CORROSION STUDIES. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Argonne National Lab., Ill., from Section 5, pp 136-213 of report CEA-N-1419. 79p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 25: 32644.

49350 (APDA-265) SODIUM-WATER REACTION ANALYSIS OF THE BABCOCK AND WILCOX PROTOTYPE STEAM GENERATOR IN THE SODIUM COMPONENTS TEST INSTALLATION. Coleman, J. H.; Hosler, A. G. (Atomic Power Development Associates, Inc., Detroit, Mich.). Dec 1970. Contract AT(11-1)-2021; Subcontract 534025-GB. 135p. Dep. NTIS.

As part of the steam generator development program, sodium-water reaction studies were performed for the B&W prototype steam generator that will be tested in the Sodium Components Test Installation (SCTI). A leak detection system is proposed based on installation of the steam generator in the SCTI. In addition to the proposed system, the results of an analysis of the effectiveness of the system are presented along with the model and computer program used. To evaluate the capability of the steam generator to withstand the pressure effects of a large leak, a pressure analysis is presented which also includes an analysis of the existing sodium-water relief system at the SCTI. Also included is a detailed description of the mathematical model and computer program used for pressure analysis. (auth)

49351 (CONF-710520-1) CORROSION TESTS OF STAINLESS STEELS IN FLOWING BALTIC SEA WATER. Henrikson, Sture; Arvesen, Jan (Aktiebolaget Atomenergi, Studsvik (Sweden)); Olsson, Jan (Avesta Jernverk A. B. (Sweden)). 1971. 8p. Dep. NTIS (U. S. Sales Only).

From sixth Scandinavian corrosion congress; Gothenburg, Sweden (24 May 1971)

Literature on corrosion generally advises against using stainless steels in sea water at flow velocities lower than 1.5 m/sec because of the increased risk of deposits and crevice attacks by marine organisms and sediments in stagnant water. Stainless steel tubes for sea water have shown varying lengths of service when used in operation. No systematic tests in flowing Baltic Sea water have been carried out. Results of corrosion tests carried out at 50°C on tube specimens in a sea water test loop and on small tube heat exchangers are presented. The tests principally comprised austenitic stainless steels in welded and unwelded condition. The water velocity varied between 0.1 and 10 m/sec and the maximum test duration was approximately 2 years. One common aspect of the test results obtained was the harmful effect of different crevices formed on the steel surface during fabrication or installation. Thus all austenitic steels showed good resistance in unwelded condition – independently of the water velocity – whereas in simulated poor assembly welds they were subjected to local attacks after a couple of months. Crevice corrosion also occurred in the tube heat exchangers at the welded tube attachments and stress corrosion cracking occurred originating from crevices at the rolled-in tube attachments. (auth) (Sweden)

49352 (CONF-710520-2) IN LINE DETERMINATION OF CORROSION RATES IN HIGH-TEMPERATURE ENVIRONMENTS BY THE LINEAR POLARIZATION METHOD. Huebner, Walter (Aktiebolaget Atomenergi, Studsvik (Sweden)). 1971. 11p. Dep. NTIS (U. S. Sales Only).

From sixth Scandinavian corrosion congress; Gothenburg, Sweden (24 May 1971).

By using electrochemical methods for continuous in-line measurement of corrosion rates in high temperature equipment, unexpected corrosion damage and service interruptions can be greatly reduced. A brief survey is given of corrosion rate measurements by means of linear polarization measurements. Equipment for electrochemical measurements at high temperature by

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polarization has been studied in a series of tests in water at 250°C for carbon steel at pH 3 and pH 7.5 and for stainless steel at pH 7.5. IR-drops due to resistance polarization were eliminated by a bridge circuit. Transient techniques have been used in order to minimize the time necessary for measurements. Tafel constants have been determined by polarization in the logarithmic range, and corrosion currents were also obtained by extrapolation to the corrosion potential. Using the experimentally determined Tafel constants the corrosion currents as a function of time were calculated from the slope in the linear polarization region. The corrosion rates thus obtained were compared with measurements of descaled weight loss, reasonable agreement being found. (auth) (Sweden)

49353 (CONF-710520-3) STRESS CORROSION OF TWO STAINLESS POTENTIAL PRESSURE VESSEL STEELS WITH MIXED PHASE STRUCTURE. de Pourbaix, Marian (Aktiebolaget Atomenergi, Stockholm (Sweden)); Huebner, Walter (Aktiebolaget Atomenergi, Studsvik (Sweden)). [1970]. 11p. Dep. NTIS (U. S. Sales Only).

From sixth Scandinavian corrosion congress; Gothenburg, Sweden (24 May 1971).

Investigations have been made of Avesta 248SV and Bofors 2RMO, two potential pressure vessel steels with mixed phase structure, characterized by high strength. Stress corrosion tests have been made up to 8000 hr in a chloride-containing medium at 300°C both in liquid phase and vapor phase. The results show that chloride initiated corrosion cracking may take place also in these mixed structure alloys. The resistance to stress corrosion cracking in 5 ppM Cl-solution at 300°C is comparable for the two steels and comparable with or better than that for austenitic 18/10 steel. The effect of temperature and chloride content on the time to cracking is discussed. The appearance of the stress corrosion cracks is described, and the sensitivity of the austenitic-martensitic and austenitic-ferritic-martensitic steels is compared with that of austenitic 18/10 steel. Potentiostatic stress corrosion tests have been made in $CaCl_2$ and NaCl solutions at 100 and 25°C. In tempered steel the cracking was accelerated by anodic polarization, while no attacks were observed after a long period of cathodic polarization. With hardened steel, on the other hand, quick fracture occurs in cathodically polarized specimens. The results indicate that the corrosion cracking in neutral chloride solutions on normally tempered steel is of anodic type, i.e., stress corrosion, whereas hydrogen embrittlement in a neutral chloride solutions takes place only in steel with other heat treatment. (auth) (Sweden)

49354 (COO-2069-19) STUDY OF THE MECHANISMS OF STRESS CORROSION CRACKING IN THE IRON-NICKEL-CHROMIUM ALLOY SYSTEM IN CHLORIDE ENVIRONMENTS. [Progress Report], October 1, 1970-June 30, 1971. Staehle, R. W.; Slater, J. E. (Ohio State Univ. Research Foundation, Columbus). Contract AT(11-1)-2069. 31p. Dep. NTIS.

Results are reported on circulating autoclave tests, transient electrode experiments, and investigations into the role of nitrogen in the cracking process. Owing to the lack of funds to support the research, this is the last report. Results of circulating autoclave studies showed that increasing pH to 10.9 significantly increased failure times for 304 steel and USS 18-18-2. The construction of an apparatus for studying transient electrochemical phenomena occurring during and after very high speed elongation is described, and preliminary experiments on Fe in pH 9 buffer are reported. Increasing the nitrogen content of ferritic Fe-Ni and austenitic Fe-Ni-Cr alloys has been shown to increase their susceptibility to stress corrosion cracking and to change their electrochemical behavior. (auth)

49355 (JAERI-Memo-4355) INFLUENCE OF SOME FACTORS AFFECTING THE CORROSION FATIGUE OF A LOW ALLOY STEEL IN HIGH TEMPERATURE WATER. Kondo, Tatsuo; Kikuyama, Toshihiko; Kobayashi, Sadamu; Nakajima, Hajime; Shindo, Masami (Japan Atomic Energy Research Inst., Tokyo). Feb 1971. 22p. (In Japanese). Dep. NTIS (U. S. Sales Only).

The effect of high-temperature aqueous environments on the rate of fatigue crack growth was studied. The apparatus consists of two electro-hydraulic fatigue machines combined with a water circulating system. The fatigue character of the material in water up to 280°C was compared with that in ambient air. The parameters tested were: temperature, strain-range, loading frequency, and water quality. Measurements were made on both the number of cycles to failure and the rate of crack growth under fixed displacement amplitudes. In the aqueous environment the fatigue life of the specimens was generally reduced relative to that in ambient air under most testing conditions. Such reduction was more pronounced as the loading frequency is lowered to around 1 cycle/min., below which, however, the growth slowed. The specimen life was prolonged in low-frequency range in random fashion. The crack growth rate was increased with temperature up to around 200°C, but above which the trend was reversed. The growth rate in water was more dependent on the strain range than in air, thus the environmental effect was more evident at higher stress or strain ranges. (auth)

49356 (ORNL-TM-3300, pp 174-81) SODIUM CORROSION STUDIES. Harms, W. O.; DeVan, J. H. (Oak Ridge National Lab., Tenn.).

Microhardness profiles for V and V alloy specimens that had acquired O from Na at 600°C were compared. The profiles corroborated conclusions concerning O distribution that had previously been deduced from measurements of weight gain, O analyses, and metallography. Metallographic studies of V-20% Ti oxidized in low-pressure O_2 showed that the oxidation front representing internal precipitation of Ti was followed by a second front, presumably caused by transformation of α-phase V to β-phase V. The microstructures of V-20% Ti exposed to the gaseous environment were identical to those previously observed in Na tests. (auth)

49357 (ORNL-TM-3300, pp 182-7) SODIUM REMOVAL AND CAUSTIC EFFECTS. Harms, W. O.; DeVan, J. H. (Oak Ridge National Lab., Tenn.).

The ALCO/BLH steam generator, which experienced leakage of water into Na while under test at the Liquid Metal Engineering Center, was shipped to ORNL for destructive examination to determine the mechanism of failure and the metallurgical integrity of the unit. Studies of the corrosion effects of Na leaks on metal surfaces in contact with mixtures of N_2 and air were conducted. An apparatus is being constructed to permit the controlled leakage of Na through a stainless steel specimen under ambient conditions that simulate those surrounding the primary containment vessel of the FFTF Reactor. (auth)

49358 (ORNL-TM-3300, pp 313-21) ADVANCED MATERIALS FOR STEAM GENERATORS. Patriarca, P.; Slaughter, G. M. (Oak Ridge National Lab., Tenn.).

Specimens of weldments of alloys for use in steam generators exposed 16,000 hr in superheated steam at 595 and 650°C were evaluated. The calculated penetrations of base metals in 20 years were all below 0.0005 in. for the Inconel 625, Hastelloy X, and IN 102 similar-metal weldments. Surfaces of Inconel 600 welded to itself with Inconel 82 filler metal were attacked at a depth of about 0.002 in. for the exposure at 595°C and about 0.003 in. for the exposure at 650°C. The amounts of corrosion for the various dissimilar-metal weldments were also low and interpretable in terms of the corrosion of the alloys of which they were made. The synthesized root pass specimens reached exposure times at 595 and 650°C ranging from 2000 to 9000 hr. Whereas the amounts and rates of corrosion usually were, as expected, significantly higher at 650°C than at 595°C for the respective alloys, temperature did not appear as important as surface preparation. The order of the amounts of corrosion for the individual surface conditions continued, but for few exceptions, to be as-welded, electropolished, belt-ground, and sandblasted. (auth)

49359 (ORNL-TM-3416, pp 150-4) SODIUM CORROSION STUDIES. (Oak Ridge National Lab., Tenn.).

In fuels and materials development program quarterly progress report for period ending March 31, 1971.

In tests designed to evaluate the effect of Cr and Mo on the diffusion coefficients of O in V at 600°C, specimens of O doped alloyed and unalloyed V were simultaneously exposed to Na. The initial results indicate that a surface reaction may control the rate of oxygen transfer between the specimens, thus making it impossible to determine diffusion coefficients. The oxidation kinetics of V-20% Ti at 1000°C was examined as a function of O_2 pressure, surface area, and surface preparation. Oxidation occurs in an initial linear stage followed by a stage in which the rate decreases with time. (auth)

49360 (ORNL-TM-3416, pp 155-65) SODIUM REMOVAL AND CAUSTIC EFFECTS. (Oak Ridge National Lab., Tenn.).

In fuels and materials development program quarterly progress report for period ending March 31, 1971.

The ALCO/BLH steam generator is being destructively examined to determine the causes of cracking in the lower tube sheet. Extensive sodium-containing deposits were apparent in the argon gas space above the sodium, and attack typical of hydroxide corrosion was found beneath these deposits. Studies of the effects of sodium leaks on the oxidation of stainless steel in nitrogen plus oxygen mixtures were terminated. The effectiveness of various sodium removal techniques was evaluated by exposing several different alloys to a short duration sodium

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soak, stripping the specimens of residual sodium, and reexposing the alloys in sodium. Reexposure to sodium caused attack in proportion to the quantity of impurities left by the stripping process. (auth)

49361 (ORNL-TM-3416, pp 239-46) ADVANCED MATERIALS FOR STEAM GENERATORS. (Oak Ridge National Lab., Tenn.).

In fuels and materials development program quarterly progress report for period ending March 31, 1971.

In assessing the effect of surface finish on the corrosion of steam generator alloys, specimens in the ground condition and others with the effects of grinding removed by electropolishing were exposed in steam for 14,000 hr at 650 and 595°C. Electropolishing substantially increased the amount of corrosion of Incoloy 800 in this period, moderately increased it for Inconel 600, but slightly decreased the amounts in the cases of Inconel 625 and Hastelloy X. Whereas the amount of corrosion on electropolished Incoloy 800 was comparatively large for this period of exposure, the total attack in 20 years still would be impressively low because its corrosion rate decreases significantly with time. Steam exposures consisting of cycling between 480°C and the steam-saturation temperature (280°C), and containing NaCl and O as contaminants, produced stress-corrosion cracking in weldments of Hastelloy X welded with itself as the filler metal. This was unexpected since some of the stainless steel specimens thought to be more crack-prone had not begun to fail. (auth)

49362 REACTION BETWEEN URANIUM–MOLYBDENUM ALLOYS AND DRY CARBON DIOXIDE AT ELEVATED TEMPERATURES. Paidassi, J.; de Smirnoff, M.; Desrues, R.; Darras, R. (CEN, Fontenay-aux-Roses, France). Corros. Sci.; 11: No. 6, 383-8(Jun 1971). (In French).

The linear oxidation of U–1% Mo and U–10% Mo alloys (in weight) in dry carbon dioxide under atmospheric pressure was compared with that of unalloyed uranium between 500 and 1000°C. It gives rise to the formation of a coating composed of perceptibly stoichiometric uranium dioxide, MoO_2 (the Mo/U proportion being the same in the coating and the original alloy), and of free or combined carbon. The addition of molybdenum increases the speed of the reaction between 500 and 600°C, and reduces it between 800 and 1000°C by factors of 20 and 100 respectively. At a given temperature, this effect appears to be in connection with a concomitant variation in the plasticity of the oxide, the amelioration of the latter leading to a reduction in the speed and vice versa. (auth) (UK)

49363 PROTECTION OF NIOBIUM AGAINST OXIDATION UP TO 1500°C WITH $MoSi_2$ COATINGS. Fitzer, E.; Schlichting, J.; Schmidt, F. K. (Univ., Karlsruhe, Ger.). High Temp. - High Pressures; 2: No. 5, 553-70(1970). (In German).

TiCr–Si coating for protecting niobium against oxidation up to 1400°C are evaluated and attention is drawn to their restricted effect. A detailed quantitative analysis is presented of the conditions for resistance to oxidation in relation to oxidation kinetics of $MoSi_2$ as compared to $NbSi_2$. It is shown that $MoSi_2$ exhibits a broader range than $NbSi_2$ of temperatures and partial oxygen pressures under which there takes place selective oxidation to glassy SiO_2. Furthermore, it is shown that the diffusion of silicon from $MoSi_2$ into the substrate through an Me_5Si_3 (Me = Mo + Nb) layer is slower by a factor of 3–4 than similar diffusion through an Mo_5Si_3 layer. Thus niobium constitutes a barrier against diffusion of silicon from $MoSi_2$. Finally, the thermal expansion coefficients of $MoSi_2$ and Me_5Si_3 are similar to that of the niobium substrate, which necessarily suggests the protection of niobium by $MoSi_2$ coatings. A powder-metallurgy method of depositing $MoSi_2$ on niobium by hot pressing is described and results are presented of oxidation tests on niobium specimens protected in this way demonstrating the protection from oxidation up to 1000 hr at 1450°C in air. The glassy layer tends to chip off during cooling; although the cracks heal, re-formation of the glassy layer is accompanied by increased consumption of the silicon in the protective coating. (auth) (UK)

49364 EXPLORATORY STUDIES OF THE MOVEMENT OF ACTIVATED CORROSION PRODUCTS. Lister, D. H. (Atomic Energy of Canada, Ltd., Chalk River, Ont.); Charlesworth, D. H.; Bowen, B. D. Corrosion; 27: No. 7, 281-8(Jul 1971).

Corrosion products formed on the internal surfaces of all water-cooled systems tend to be moved about the system by the flowing water. In a nuclear power reactor, some of the products are activated as they pass through the reactor core and then produce gamma radiation fields which can interfere with system maintenance. The factors which control the rate of movement are not well understood and therefore cannot be used to minimize the radioactive contamination of the circuit. A program of studies has been started aimed at better understanding the mechanism by which corrosion products are released, transported, then redeposited. The first stage of these studies has assessed the relative importance of factors such as coolant chemistry, hydraulic conditions, heat transfer, cycling of temperature, and flow. The tests were done in a 300°C circulating water loop containing an activated corrosion product source and a test surface continuously monitored on-line with a lithium-drifted germanium gamma-ray detector. (auth)

49365 DIFFUSION OF OXYGEN IN VAPOR-DEPOSITED TANTALUM FILMS. Langer, H.-D. (Technische Hochschule, Karl-Marx-Stadt, Ger.). pp 279-86 of Diffusion in Metallischen Werkstoffen. Leipzig; VEB Deutscher Verlag fuer Grundstoffindustrie (1970). (In German).

From seventh metal meeting; Dresden, Germany (1 Apr 1970). See CONF-700436.

The oxidation of vapor-deposited Ta films was measured at temperatures from 300 to 500°C. The composition of the oxide layers was determined. The temperature coefficient of the electrical resistance of Ta films was measured in dependence on the layer thickness. The estimation of the oxygen concentration from the variation of the specific electrical resistance or from the change of the lattice constant a_{110} was discussed. (J.S.R.)

49366 IMPROVEMENTS IN ALLOY FERRITIC STEELS. Foster, George Graham; Taylor, John Welsh (to Babcock and Wilcox Ltd.). British Patent 1,219,263. 13 Jan 1971. Filed 30 Dec 1966.

Reference is made to creep-resisting alloy steels of the types 1% Cr, 0.5% Mo or 2.25% Cr, 1% Mo. It has been found that such steels show marked variability in corrosion behavior in oxidising atmospheres, particularly at elevated temperatures and pressures, and they are not entirely suitable for nuclear reactor CO_2 pressure circuits. An important factor influencing the corrosion behavior is the amount, size and distribution of manganese sulphide impurity, and such inclusions should preferably have a mean length not greater than 15×10^{-5} inches. The alloy described has a manganese sulphide content of 0.015 "area per cent" or less, and has the composition 0.7 to 2.6% Cr, 0.4 to 1.2% Mo, 0 to 0.17% C, 0.25 to 0.7% Mn, 0.16 to 0.58% Si, 0 to 0.04% S, 0 to 0.05% P, and 0 to 0.3% Ni, with the balance comprised of iron and incidental impurities. The term "area per cent" is defined. Such an alloy is stated to be suitable for use in a CO_2 atmosphere up to 450°C and 1000 psi, or more stringent conditions if the manganese sulphide content is still further lowered. Means for controlling the manganese sulphide content are described, including variations of the casting process. (UK)

49367 CORROSION AND ELECTROCHEMICAL BEHAVIOR OF A ZIRCONIUM ALLOY WITH 2.5 PERCENT NIOBIUM IN WATER AND STEAM AT HIGH TEMPERATURES. Gromova, A. I.; Gerasimov, V. V.; Kabankova, N. A.; Shut'ko, I. G.; Volkhonskii, E. V. This paper was summarized in At. Energ. (USSR); 29: No. 5, 364-5(Nov 1970) as paper No. 440/5632. (In Russian).

The corrosion and electrochemical behavior of niobium–zirconium alloy were investigated at 285 to 300°C. A passive region is maintained up to +1.8 V; above, there is superpassivation. Raising the pH of deaerated water to 10 with NH_4OH does not intensify the corrosion, inside or outside the reactor, but the presence of both NH_3(pH 10) and oxygen in the water increases the corrosion rate. (D.L.C.)

49368 ANODIC OXIDATION OF TANTALUM. Wilcox, P. S.; Westwood, W. D. (Bell-Northern Research and Development Labs., Ottawa). Can. J. Phys.; 49: No. 12, 1543-8(15 Jun 1971).

Anodization current efficiency measurements were used to determine the oxygen content of sputtered tantalum films. Films consisting mainly of bcc Ta had less than 5 at. % oxygen while "normal" β-Ta contained 10 to 15 at. % oxygen. Films with a more negative temperature coefficient of resistance had a higher oxygen content. The field strength required to cause oxide growth on "normal" β-Ta was lower than for bcc Ta films or for oxygen-rich β-Ta films. The cause of these changes in field strength is not known. The dielectric constants of the oxides grown on all films were the same, but depended on the measurement conditions and history of the oxide. (auth)

Preparation and Fabrication

Refer also to abstracts 48576, 48728, 48754, 48768, 48836, 48847, and 48897.

49369 (AD-711930) FEASIBILITY STUDY OF NIOBIUM ALLOY CASTINGS. Quarterly Progress Report No. 3, February 1–April 30, 1970. Beauregard, R. J.; Walters, J. J. (Avco

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Lycoming Div., Stratford, Conn.). Aug 1970. Contract DAAG46-69-C-0163. 45p. (AMMRC-CR-70-5/3). NTIS.

Two pours of alloy B-66 were made into fluidity molds having two tungsten layers. One pour was made into an unheated mold, and one pour was made into a mold preheated to 1160°F. Preheating of the mold resulted in greatly improved fluidity with no serious contamination. Based on the eight B-66 fluidity castings produced so far, two-layer molds preheated to 1400°F were selected as the optimum for the production of Phase 2 test specimens and vanes. One additional pour of alloy WC-3015 was made in a one-tungsten-layer fluidity mold preheated to 1300°F. No improvement in fluidity was seen compared with previous preheated two-layer molds. Based on the eight WC-3015 fluidity castings made, two-layer molds preheated to 1400°F were selected as the optimum for Phase 2. (auth) (USGRDR)

49370 (ANL-Trans-888) ELECTROCHEMISTRY STUDIES. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Argonne National Lab., Ill., from Section 4, pp 124-8 of report CEA-N-1341. 5p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 25: 6840.

49371 (ORNL-TM-3300, pp 134-44) FABRICATION DEVELOPMENT FOR FBR CLADDING. Adamson, G. M. Jr.; Martin, W. R. (Oak Ridge National Lab., Tenn.).

A study of the relations between the size of defects in stainless steel tubing and its stress-rupture properties is continuing. An improved type of artificial defect with depths equal to 10% of the wall thickness reduces the properties of the tubing at 650°C. All failures in defected tubes were at the site of the artificial defect. A bench test was completed that showed that surface defects can be introduced into the cladding during fuel loading; long scratches 0.0002 to 0.0003 in. deep were documented. (auth)

49372 (ORNL-TM-3300, pp 145-58) WELDING DEVELOPMENT FOR FBR STAINLESS STEEL COMPONENTS. Weir, J. R. Jr.; Slaughter, G. M.; Goodwin, G. M. (Oak Ridge National Lab., Tenn.).

Results of creep-rupture tests of submerged-arc weldment specimens showed that ductility (total elongation) decreased with longer rupture lives. A weldment prepared with Hobart HS-300 flux showed atypical results compared with other submerged-arc welds. Heat treatment of 75 tensile specimens was completed except for the 1000-hr aging. An additional gas metal-arc weld was prepared with a 98% Ar-2% gas mixture. A section of weld made in 2-in. plate with 1/4-in. electrodes containing controlled amounts of minor elements was procured. Creep-rupture tests were performed on heat-treated shielded metal-arc welds containing B; in general, the heat treatments studied reduced the rupture lives but did not adversely affect ductilities. A lot of 232 weldment specimens was delivered to WADCO for irradiation testing. Further studies were conducted to determine the effects of various heat treatments on microstructure. Solution anneals up to 1190°C had varying effects on the amount of ferrite taken into solution in several different welds. (auth)

49373 (ORNL-TM-3300, pp 159-69) PROPERTIES OF FERRITIC STEEL WELDS. Weir, J. R. Jr.; Slaughter, G. M. (Oak Ridge National Lab., Tenn.).

A search of the literature for stabilized low-alloy steels was used as basis for ordering commercial material. Cracking in TIGAMAJIG weldments in stabilized low-alloy steel was observed; however, backfilling of these cracks by a low-melting phase makes them difficult to detect. An extensive electron-beam microprobe analysis showed these liquated regions to be rich in Nb. This Nb enrichment can result in the formation of a low-melting eutectic Fe_2Nb δ-phase. The enrichment in Nb is derived from the NbC precipitates which, at elevated temperatures, decompose and thereby provide the high level of Nb necessary to produce the eutectic structure. (auth)

49374 (ORNL-TM-3300, pp 245-62) TUNGSTEN METALLURGY. Patriarca, P.; Schaffhauser, A. C. (Oak Ridge National Lab., Tenn.).

Preliminary experiments on dispersion strengthening of W by gas entrainment of particles during chemical vapor deposition (CVD) are reported. Results of studies on the effects of the ratio of H_2 to metal fluoride on the quality of CVD W-25% Re alloys showed that the best deposits were formed from nearly stoichiometric ratios. The initial results of bend tests of gas tungsten-arc welds in W-25% Re sheet showed that the addition of W-25 at. % Re-30 at. % Mo and Mo-50% Re filler metals were detrimental to the bend ductility. Data for the time of 1% creep for CVD W are presented as a function of stress at 1400, 1650, and 2200°C. Specimens from several deposits of CVD W were tested at 1650°C; the data are in good agreement. The initial creep-rupture tests of W-3.8% ThO_2 at 1400 to 2200°C showed the material to be about twice as strong as unalloyed W. Six ultra-high-vacuum creep machines were procured and installed for long-time creep tests at low strains. Additional creep tests on W-25% Re in low-pressure O_2 showed that the formation of a surface layer of σ-phase significantly strengthens the material. A new task on fast-neutron irradiation damage in W alloys was begun. Existing data are summarized, and preliminary design of an irradiation experiment is reported. Base-line data for electrical resistivity are being determined. (auth)

49375 (ORNL-TM-3300, pp 295-303) JOINING RESEARCH ON NUCLEAR MATERIALS. Weir, J. R. Jr.; Slaughter, G. M. (Oak Ridge National Lab., Tenn.).

Two of the experimental Incoloy 800 alloys used as filler metal in weldments in 1/2-in.-thick Incoloy 800 plate failed to pass bend tests; one of these contained additions of S and P, and the other was high in C content. Three filler-metal alloys cracked during welding. Results of metallographic studies of autogeneous electron-beam and gas tungsten-arc welds on annealed and on 50% cold-worked experimental stainless steel drop castings showed a band of what appeared to be tempered martensite in the heat-affected zones of those alloys undergoing strain-induced transformation to martensite during welding. This band was not seen in the more stable alloys. Electron microscopy of the alloys that contained martensite indicated that the microstructures of these alloys consisted of austenite with a high density of dislocations and bands of ε phase; the martensitic needles occurred within these bands. (auth)

49376 (ORNL-TM-3416, pp 109-15) FABRICATION DEVELOPMENT OF FBR CLADDING. (Oak Ridge National Lab., Tenn.).

In fuels and materials development program quarterly progress report for period ending March 31, 1971.

An examination of the relations between defect size and the stress-rupture properties of cladding is continuing. A technical report describing results with cold-worked Type 316 stainless steel is in the process of being published. Work on the planetary swaging of Type 316 stainless steel has been completed and a report has been written. (auth)

49377 (ORNL-TM-3416, pp 116-42) WELDING DEVELOPMENT FOR FBR STAINLESS STEEL COMPONENTS. (Oak Ridge National Lab., Tenn.).

In fuels and materials development program quarterly progress report for period ending March 31, 1971.

The mechanical properties, both creep-rupture and tensile, of submerged-arc welds in stainless steel are being determined. There is a general decrease in rupture elongation as rupture time increases. However, there are unexplainable differences in rupture strengths for several welds, and research is being conducted to determine the reason. The results of a preliminary evaluation of the tensile data are presented. A comprehensive evaluation of shielded metal-arc welds is also under way. This involves mechanical properties, heat treatment effects, and corrosion studies. Heat treatments lowered the rupture lives by about one order of magnitude. The results of a metallographic examination of welds exposed to a wide variety of heat treatments are reported. Factors influencing sigma-phase formation are receiving particular attention. Strauss tests on a number of as-welded and welded-and-heat-treated samples have been performed. (auth)

49378 (ORNL-TM-3416, pp 143-7) PROPERTIES OF FERRITIC STEEL WELDS. (Oak Ridge National Lab., Tenn.).

In fuels and materials development program quarterly progress report for period ending March 31, 1971.

Studies have been conducted on welds in low-carbon low-alloy steels. At 565°C, there is a measurable difference in the ultimate tensile strength between the low-carbon (0.003%) and high-carbon (0.11%) steels studied. Subjecting the welds to a postweld heat treatment at 700°C for 1 hr resulted in a strength difference of 50,000 psi vs 69,000 psi. All welds had excellent reduction-in-area values (in excess of 80%) after the postweld heat treatment. Evidence of a deleterious effect of low strain rate on the ductility of the weld metal is shown. Hardness data indicate that the strength of the as-welded heat-affected zone of the low-carbon steel is low. Thermal excursions associated with multipass weld techniques are beneficial and perhaps final passes for reasons of heat treatment may be required. Stabilized low-alloy steel slabs 1-in. thick have been received and are being rolled to 1/2- and 1/4-in. thicknesses for subsequent weldability studies. (auth)

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49379 (ORNL-TM-3416, pp 184-91) CLADDING MATERIALS FOR SPACE ISOTOPIC HEAT SOURCES. (Oak Ridge National Lab., Tenn.).

In fuels and materials development program quarterly progress report for period ending March 31, 1971.

Research is continuing to qualify Pt-Rh-W alloys for use as isotopic heat source cladding materials. Fabrication procedures have been developed for the production of small quantities of sheet and rod. The recrystallization temperature of Pt-26% Rh-8% W cold worked 35% was found to be about 1050°C; grain growth was slow below 1400°C. The Pt-26% Rh-8% W alloy was found to be stronger than Pt-30% Rh at all temperatures and equivalent to TZM at 1316°C. Air oxidation of Pt-Rh-W alloys to 1200°C is higher than pure Pt. Results of compatibility evaluations of Pt-Rh-W alloys with T-111 at simulated reentry temperatures indicate an improvement of about 100°F is possible over the Pt-30% Rh/T-111 capsule combination. No indication of interaction was evident upon aging 1000 hr at 900°C. The compatibility of CVD tungsten as a diffusion barrier in contact with Pt-26% Rh-8% W was found to be excellent at simulated reentry temperatures as high as 1600°C. Long time tests at lower temperatures are in progress. Gas tungsten-arc welds on 20-mil sheet were found to be ductile and without cracks in the as-welded condition and after bending 90°. (auth)

49380 (ORNL-TM-3416, pp 207-13) TUNGSTEN METALLURGY. (Oak Ridge National Lab., Tenn.).

In fuels and materials development program quarterly progress report for period ending March 31, 1971.

Experiments on the chemical vapor deposition (CVD) of tungsten with a dispersion of fine particles were not successful in obtaining the desired volume fraction of particles. Studies on CVD of small diameter W-25% Re thermocouple sheath tubes showed that the deposition conditions producing the highest quality tubes resulted in slow deposition rates and low metal recovery. A creep testing program is in progress in which the determination of the low strain creep behavior of CVD tungsten for test times greater than 1000 hr is emphasized. Six ultrahigh-vacuum creep machines with optical strain measurement capability have been installed and are undergoing operational checkout. In another phase of the creep testing program, the creep strength of tungsten at 1800°C was found to be lower in a partial pressure of CH_4 than in vacuum. Determination of the high-temperature electrical resistivity and Seebeck coefficient of tungsten and tungsten alloy control specimens is under way. The low-temperature physical properties of tungsten alloys are being evaluated to allow accurate application of the alloying method of component separation. (auth)

49381 (ORNL-TM-3416, pp 224-31) JOINING RESEARCH ON NUCLEAR MATERIALS. (Oak Ridge National Lab., Tenn.).

In fuels and materials development program quarterly progress report for period ending March 31, 1971.

Tensile tests at 650°C have been completed on the Incoloy 800 welds made with both experimental and commercially obtained filler metals. Two of the commercially produced alloys were submitted by International Nickel Company for evaluation. They compared favorably with the recommended filler metal (Inconel filler metal 82) for joining Incoloy 800. An investigation of a microfissured electron-beam weld which joined an Inconel 600 tube to an Inconel-82-clad carbon steel tube-sheet was conducted. The microfissure occurred in the overlay (the heat-affected zone of the weldment) at a location in which a stress concentration occurred due to the weld bead geometry. The microfissure was attributed to liquation of a Nb-rich phase during welding. The Schaeffler Diagram, which is often employed for predicting the amount of ferrite in autenitic stainless steel welds, does not include a factor for the effects of heat input. Further, high Mn contents tend to provide erroneous ferrite predictions. Alloys with 5% Mn which are predicted to be all austenite were found to contain from 3 to 8% ferrite. (auth)

49382 (RT/MET-(70)7) PREPARATION OF ALLOYS OF ZIRCONIUM. Fizzotti, C.; Gandini, A. G.; Ascenzioni, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 10 Sep 1970. 19p. (In Italian). Dep. NTIS (U. S. Sales Only).

Fabrication techniques developed at the Material Technology Laboratory to produce small quantities of particular zirconium alloys are described. The alloys taken into consideration: Zircaloy-2, zirconium-chromium-iron, and Ozhennite 0.5. (auth)

49383 (SCL-DR-710040) RING SHEAR TEST FOR QUANTITATIVELY MEASURING ADHESION OF METAL DEPOSITS. Dini, J. W.; Helms, J. R.; Johnson, H. R. (Sandia Labs., Albuquerque, N. Mex.). May 1971. Contract AT(29-1)-789. 32p. Dep. NTIS.

Ring shear tests for measuring adhesion of metal deposits were conducted to determine the best methods of preparing substrates for plating. A metal rod was masked with tape or tubing at one-inch intervals, coated with a deposit, machined, and forced through a steel die having a hole larger in diameter than the rod but smaller than that of the rod plus coating. Test results are given for the following deposits and substrates: gold on stainless steel, nickel on AM363 stainless steel, nickel on uranium, nickel and electroless nickel on aluminum. The results showed that quantitative, reproducible data can be obtained by this test method and also revealed the best procedures to use for preparing particular substrates. (auth)

49384 (UCRL-73121) USE OF ELECTRODEPOSITION METHODS TO PREPARE ACTINIDE TARGETS FOR CROSS SECTION MEASUREMENTS AND ACCELERATOR BOMBARDMENTS. Evans, J. E.; Lougheed, R. W.; Coops, M. S.; Hoff, R. W.; Hulet, E. K. (California Univ., Livermore. Lawrence Radiation Lab.). 1 Jul 1971. 35p. (CONF-711002-1). Dep. NTIS.

From third international symposium on research materials for nuclear measurements; Gatlinburg, Tenn. (5 Oct 1971).

Techniques are described which were developed to produce various actinide targets. A typical target consists of an actinide compound deposited on a metal foil in a layer thin enough to allow various charged particles to pass through the deposit without undue energy loss. The thickness of the deposits ranged from negligible mass up to 1 mg/cm^2. The techniques described include deposition of Pu and Am onto Ni foil from 5 M NH_4Cl solutions, deposition of Pu, Cm, Bk, Cf, and Es onto stainless steel foil from isopropyl alcohol-HNO_3 solutions, deposition of Cf, Es, and Fm onto Be and Pd foils from dilute HNO_3 solutions, and chemical deposition of U onto Al foils. For each method the application for which it was used, the equipment required, the composition of the electrolyte, other experimental conditions, and the advantages and disadvantages of the technique are examined. (auth)

49385 PREPARATION OF METALLIC PROLATE SPHEROIDS. Sekula, S. T.; Kernohan, R. H.; Cantrell, E. S. (Oak Ridge National Lab., Tenn.). Rev. Sci. Instrum.; 42: No. 8, 1187-9(Aug 1971).

A technique is described for the electrical discharge machining of elongated spheroid specimens from metallic rods using conventionally milled electrodes. Specimens of Nb, Ta, Re, and Nb-Ta alloys have been satisfactorily prepared. For single crystals of Nb, x-ray study results indicate the absence of any recrystallization after heat treatment of the prolate spheroids to remove strains. (auth)

49386 METHOD OF MAKING A NUCLEAR FUEL PLATE. Triggiani, Leonard Vincent; Sanchez, Moises Gali; Ashby, George Elliott (to W. R. Grace and Co.). U. S. Patent 3,586,746. 22 Jun 1971. Filed 28 Feb 1968.

A process for improving the fuel-bearing phase of a dispersion type nuclear fuel plate, in which individual foils are impressed with cells of controlled dimension and shape in a regular array, and fuel particles containing the fissile materials are inserted into the cells by vibration, compression, suction, or other means. The foil is then laminated to additional foils to yield a unitized fuel plate with the fuel particles dispersed uniformly throughout. (Official Gazette)

49387 METHOD OF PREPARING A FUEL PLATE CONTAINING DENSIFIED FUEL PARTICLES. Triggiani, Leonard Vincent; Sanchez, Moises Gali; Ashby, George Elliott (to W. R. Grace and Co.). U. S. Patent 3,586,745. 22 Jun 1971. Filed 28 Feb 1968.

A process is given for improving the utility of the fuel-bearing phase of a dispersion type nuclear fuel plate, in which individual foils are impressed with cells of controlled dimension and shape in a close-packed array, and dense microspherical fuel particle containing the fissionable materials are inserted in the cells by vibration, compression, suction, or other means. The foils are then laminated to additional plates to yield a unitized fuel plate with the fuel particles dispersed uniformly throughout and with sufficient void space in each of the cells to take care of fission gases and any expansion in individual fuel particles. (Official Gazette)

49388 METHOD OF PREPARING A FUEL PLATE CONTAINING LOW DENSITY FUEL PARTICLES. Triggiani, Leonard Vincent; Sanchez, Moises Gali; Ashby, George Elliott (to W. R. Grace and Co.). U. S. Patent 3,586,744. 22 Jun 1971. Filed 28 Feb 1968.

A process is given for improving the fuel-bearing phase of a dispersion type nuclear fuel plate, in which individual foils are impressed with cells of controlled dimension and shape in a regular array, and fuel particles having a density of about 50% of theoretical, containing the fissile materials, are inserted in

the cells by vibration, compression, suction or other means. The foils are then laminated to additional fuel-bearing foils and outer foils that contain no fissile material and then compressed to yield a unitized fuel plate with the fuel particles dispersed uniformly throughout. (Official Gazette)

49389 PREPARATION OF ACTINIDE (+ ZIRCONIUM AND HAFNIUM)-NOBLE METAL ALLOY PHASES BY COUPLED REDUCTIONS. Erdmann, B.; Keller, C. (Kernforschungszentrum, Karlsruhe, Ger.). Inorg. Nucl. Chem. Lett.; 7: No. 7, 675-83(Jul 1971).

A series of intermetallic phases, Pt_5M, Pt_3M, and Pd_3M (M = Th to Cm), and also including Pt_2Pu, were prepared by reduction of the corresponding actinide oxides with extremely purified hydrogen in the presence of platinum or palladium, respectively. The preparation of Pt_3Pa, Pt_5Pa, Pt_3Np, Pt_5Np, Pt_5Am, Pt_5Cm, Pd_3Np, and Pd_3Am is reported for the first time. The structure of all these compounds, except that of Pt_3Pa, was elucidated. The principle used, coupled reduction, was also applied for the preparation of Hf and Zr alloy phases with platinum metals (Pt, Pd, Ir, Rh), as well as for some Pd and Rh-uranium alloy phases. The phases obtained were identified by x ray investigations. Thermogravimetric determinations of the oxygen content of some of these alloys yielded values of less than 500 ppM O_2. (auth) (UK)

49390 EXAMINATION OF EXPLOSIVE WELDED Zr–2.5 Nb/STEEL AND Zr–2.5 Nb/STAINLESS STEEL JOINTS. Beghi, G.; Schauer, G. (CCR-EURATOM, Ispra, Italy). Energ. Nucl. (Milan): 18: No. 7-8, 419-24(Jul-Aug 1971). (In Italian).

Zr–2.5% Nb tubes were joined to steel tubes or stainless steel tubes by explosive welding. The metallurgical bond was studied by metallography, quantitative determination of the composition of the weld hardness measurements, and thermal stability at 400°C. (auth)

49391 RECENT DEVELOPMENT IN DIFFUSION WELDING. Masumoto, Isao (Nagoya Univ., Japan); Tamaki, Koreaki; Terai, Kiyoshi; Nagai, Yoshio. Nippon Kinzoku Gakkai Kaiho; 9: No. 10, 653-65(Oct 1970). (In Japanese).

Diffusion welding has been developed in the USSR and the USA to meet the demands in the aeronautics and space and nuclear industries. The advantages are the welding at low temperature, integrity of base metal, and less deformation of weld. The characteristic features of the technique are the migration of atoms through the interface, recrystallization or crystal growth through it, and the elimination of bond-preventing films. The following are described: the factors in diffusion welding, including temperature, atmosphere, pressure, deformation, surface cleanliness, etc.; the welding devices and jigs utilizing induction and resistance heating, thermal-expansion difference jig, gas-pressure bonding, and electric blanket heating; metals for diffusion welding including beryllium, titanium, zirconium, tungsten, molybdenum, niobium, nickel-based alloys, stainless steel, copper and aluminum alloys, combinations of different types of metals, and ceramics; and application in aeronautical and chemical industries. (Japan)

49392 CRYSTALLIZATION OF GALLIUM-BASED ALLOYS AT HIGH GROWTH RATES. Borisov, V. T.; Matveev, Yu. E. (Central Scientific-Research Inst. of Ferrous Metallurgy, Moscow). Sov. Phys.-Cryst. (Engl. Transl.); 16: No. 1, 207-8(Jul-Aug 1971).

Translated from Kristallografiya; 16: No. 1, 249-50(Jan-Feb 1971).

The kinetics of crystal growth in thin layers of Ga, Ga–Sn, and Ga–In alloys was measured, and the dependence of the crystal growth rate V on the supercooling ΔT was plotted. The V – ΔT curves for both alloys are considerably lower than for pure Ga. Addition of Ag to the Ga–4% In alloy accelerates crystallization. (D.L.C.)

49393 METHOD FOR SETTING OUT THE STRUCTURE OF THE NUCLEAR FUEL INDUSTRY WITHIN A LONG-RANGE PROGRAMME. Bercovici, M.; Szmuk, Al. Stud. Cercet. Energ. Electroteh.; 19: 733-9(1969). (In Rumanian).

Mathematical relations are set up allowing for digital computation of the structure of the nuclear fuel industry and moderator manufacture and for estimating the costs involved by these industries within a long-range program for the development of nuclear power in our country along two trends, one based on converter–reactors and the other on fast breeder reactors. (Rom. Sci. Abstr.)

49394 WELDING OF PRIMARY SHIELDING MATERIALS FOR THE MUTSU NUCLEAR SHIP REACTOR. Koyama, Takenobu; Ueshima, Hiroyoshi; Ideda, Kazuhiro (Kisha Seizo Kaisha, Ltd., Osaka). Yosetsu Gijutsu: 18: No. 11, 81-7(Nov 1970). (In Japanese).

Steels used for lower primary shielding tank and others are required to be superior in order to pass the JIS examination. Soft steel materials were cut with gas and the others with machines. Dimensional accuracy of the products was comparatively high so that weld shrinkage was taken into account when they were cut. Edge preparations, in principle, were cut with gas then were finished by grinding. Each part was fabricated by welding. In welding, various jigs were used to reduce strains to a minimum. Automatic and semi-automatic welding were used as often as possible. Turning rolls and positioners were used so that the welding position was discovered. These were attempts to improve quality of weldments and efficiency of welding. Primary parts of each equipment were 50 mm and 32 mm thick; therefore, it was preheated at 70 to 100°C while filler metals were inserted to raise the speed of automatic welding at thick sections. (Japan)

49395 METHOD OF FUSION WELDING TOGETHER OF WORKPIECES OF ZIRCONIUM OR ZIRCONIUM ALLOYS. Brossa, Francesco; Ferrari, Giovanni Massimo; Musso, Giuseppe (to EURATOM). British Patent 1,243,116. 18 Aug 1971. Priority date 13 May 1968, Italy.

A method for welding Zr and its alloys is given which prevents increases in the grain size. In the method, a nucleation seed is introduced into the molten pool in the welding region during the welding operation. The nucleation seed is a copper and/or lithium compound which is added to the molten pool or to the electrodes. Preferably, the addition is made by immersion in molten $CuCl_2$ or LiCl in an inert atmosphere at 430 to 600°C. Two examples are given (arc welding of Zircaloy-2 pipes and electron-beam welding of Zr–Nb alloy pipes). (D.L.C.)

49396 WORKING OF METAL AND METAL ALLOY BODIES. Raviv, Samuel; Rabinovitz, Elsa; Malkeily, Shimon (to State of Israel Atomic Energy Commission). British Patent 1,234,463. 3 Jun 1971. Priority date 29 Feb 1968, Israel.

A method for working a hard metal or metal alloy, such as dissolution of a clad U fuel element, comprises establishing an electrolytic circuit including an electrolyte with an anode and cathode immersed in the electrolyte. The electrolyte is HNO_3, and the electrodes are inert to the electrolyte under the operating conditions provided that the cathode is of a different material than the body to be worked. The body is introduced into the electrolyte in a proximity relationship with the cathode, and a unidirectional electric current is flowed through the circuit to bring about local dissolution of the body. After the desired degree of dissolution is achieved, the body is removed. (B.L.M.)

49397 IMPROVEMENTS IN OR RELATING TO WELDING OF METALLIC MATERIALS. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,233,062. 26 May 1971. Priority date 18 Jul 1967, Germany.

Dissimilar metals or alloys can be welded by a process employing an electron beam to impinge on a region of only one of the metals at a point 0.07 to 0.2 mm remote from the joint. This process reduces or eliminates the intermetallic phase(s) that adversely affect the strength of the weld in the weld seam between the materials. (B.L.M.)

49398 VANADIUM-BASE ALLOY. Wincierz, Peter; Ruhle, Manfred; Reddemann, Bernhard Hermann; Schirra, Manfred; Bohm, Horst Otto (to Metallgesellschaft Aktiengesellschaft). British Patent 1,234,533. 3 Jun 1971. Priority date 24 May 1968, Germany.

V-base alloys are described, which are free from Nb and contains 0.1 to 2.8 wt % of at least one of the elements Ti, Zr, and Hf, 0 to 2 wt % Si, p to 4 wt % Ge, and traces of usual metallic impurities due to the process of producing the V. The properties of the alloys are also described. (B.L.M.)

49399 NONELECTROLYTIC SILICIDING OF VN-2 ALLOY IN MOLTEN SALTS. Anfinogenov, A. I.; Belyaeva, G. I.; Ilyushchenko, N. G. (Inst. of Electrochemistry, Sverdlovsk, USSR). J. Appl. Chem. USSR (Engl. Transl.); 44: No. 1, 82-4(Jan 1971).

Translated from Zh. Prikl. Khim.; 44: No. 1, 87-90(Jan 1971).

Nonelectrolytic siliciding of VN-2 (Nb-base alloy) was performed at 900 and 1000°C in an equimolar mixture of KCl and NaCl and in the same mixture with additions of NaF or sodium fluorosilicate. Most satisfactory results were obtained by addition of 14% sodium fluorosilicate, and a mechanism for the deposition of the silicide layer based on the interaction of alloy with silicon subions is postulated. (B.L.M.)

49400 RADIOACTIVE PLATING FOR RADIOACTIVE FOILS Wallhausen, Clarence W.; Buck, Walter F. (to Nuclear Radiation Developments, Inc.). U. S. Patent 3,567,943. 2 Mar 1971. Filed 19 Jul 1967.

XUM

Gold alloyed with from 0.10 to 25.0% of Co, Cd, Ni, Cu, or Ag forms a superior plating material for the core of a radioactive foil. (Official Gazette)

Properties Evaluations

Refer also to abstracts 48739, 48766, 49550, 49998, 50000, 51022, and 51194.

49401 (AD–714819) CYCLIC YIELD BEHAVIOR OF POLYCRYSTALLINE NIOBIUM. Agrawal, Satish K.; Stephens, Ralph I. (Iowa Univ., Iowa City. Dept. of Mechanical Engineering). Oct 1970. Contract DAAF03-69-C-0014. 31p. (THEMIS-UI–26). NTIS.

Previous investigations showed that the room temperature upper and lower yield point stress of bcc iron and molybdenum can be completely removed by initially "elastic" cyclic stressing above the fatigue limit. The research described shows the upper and lower yield point stress in niobium can also be removed under these same conditions. The cyclic stress–strain curve of niobium was found to cyclically strain soften at small strain amplitudes and cyclically strain harden at large strains. Under constant cyclic strain amplitudes in the inelastic region niobium cyclically strain hardens and quickly reaches a stable hysteresis loop. The described cyclic yield point behavior was explained in terms of localized cumulative multiplication of mobile dislocations. (auth) (USGRDR)

49402 (AD–720287) THERMODYNAMICS OF VANADIUM ALLOYS. PART II. MASS SPECTROMETRIC DETERMINATION OF THERMODYNAMIC PROPERTIES OF VANADIUM–TITANIUM–CHROMIUM ALLOYS. Final Report, January 1969–April 1970. Hoch, M.; Oblinger, C. J.; Rolinski, Edmund J. (Cincinnati Univ., Ohio. Dept. of Materials Science and Metallurgical Engineering). Oct 1970. Contract F33615-67-C-1565. 95p. (AFML-TR–70-119(Pt.2)). NTIS.

The Knudsen effusion method was combined with a mass spectrometer sensing technique in order to measure thermodynamic quantities of solid solution alloys of V-Ti-Cr in the bcc beta phase. The technique makes use of the regular solution model in order to treat the vaporization data in terms of ion current ratios obtained from the mass spectrometer. The incipient melting points of twenty-two ternary alloys were determined. The temperature range of the vaporization experiments was limited from 1400 to 1700°C for alloy compositions ranging from 10 to 66 at. % of each of the three components of the ternary system. Within the experimental temperature range, a regular solution model modified for ternary interactions represented the thermodynamic behavior in the bcc beta phase. Interaction parameters for Ti-C, V-Cr, and Ti-Cr were found to be temperature independent. However, a temperature dependent interaction parameter was determined for the Ti-Cr system when the ternary alloy data and data on the binary system in the literature were combined. An expression for the temperature dependent interaction parameter for the Ti-Cr system was obtained using both binary and ternary alloy data. The experimental results on the interaction parameters agree with calculated estimates from phase diagrams and theoretically calculated values. (auth) (USGRDR)

49403 (AD–720288) THERMODYNAMICS OF VANADIUM ALLOYS. PART III. RELATIVE IONIZATION CROSS SECTIONS OF TRANSITION METALS USING TIME-OF-FLIGHT MASS SPECTROMETRY. Final Report, January 1969–April 1970. Hoch, M.; Oblinger, C. J.; Rolinski, Edmund J. (Cincinnati Univ., Ohio. Dept. of Materials Science and Metallurgical Engineering). Oct 1970. Contract F33615-67-C-1565. 25p. (AFML-TR–70-119(Pt.3)). NTIS.

The ion current ratio data, treated using a modified form of the regular solution model, can be used to calculate relative electron impact ionization cross sections. Although this was not the primary reason for this research, the method outlined indicates that the ion current ratio data are thermodynamically consistent. The method outlined, while based on experimental ion current ratio data, makes use of absolute vapor pressure data from other sources and shows the dependency of calculated cross sections on these vapor pressure measurements. Thus, the calculation of relative electron impact ionization cross sections seems to be as good as available data on absolute vapor pressure measurements. (auth) (USGRDR)

49404 (AERE–R–6783) COMPATIBILITY OF LEAD AND NIOBIUM AT 1400°C. Skelton, P. J. (Atomic Energy Research Establishment, Harwell (England)). May 1971. 25p. Dep. NTIS (U. S. Sales Only). UK 40p.

Tests on the compatibility of lead and niobium at 1400°C showed inter-angular attack and mass transfer over a period of 720 hours. Analysis of crystals of the lead adhering to the samples showed a two-phase mixture, one of lead and the other of a 97% Nb 3% Pb structure. (auth) (UK)

49405 (BMI–1909) MECHANICAL PROPERTIES OF SHOCK STRENGTHENED AUSTENITIC STAINLESS STEEL. Kangilaski, M.; Bauer, A. A. (Battelle Columbus Labs., Ohio). Jun 1971. Contract W-7405-eng-92. 40p. Dep. NTIS.

The mechanical properties of Types 304 and 316 stainless steel were determined after the specimens had been shock strengthened by means of either a flyer plate or contact explosives. Shocking was found to significantly increase the yield strength and proportional limit, moderately increase the ultimate strength, and generally decrease the ductility, although an intermediate increase in ductility with increasing shocking pressure was noted in material shock strengthened by means of a flyer plate. The magnitude of the change in tensile properties increased with shocking pressure (80 to 320 kbar) and held for all testing temperatures. The microstructure of shock-strengthened austenitic stainless steel exhibited fine striations when examined by light microscopy, while a high dislocation density and mechanical twins were identified by transmission electron microscopy. Annealing of the shock-strengthened material for 1 hr at 900°C resulted in the disappearance of the defect structure and the changes in mechanical properties. Shock strengthening reduced the minimum creep rate of Type 316 stainless steel by a factor of about 100 and that of Type 304 stainless steel by a factor of about 1000 at 650°C for stresses ranging from 25,000 to 35,000 psi. (auth)

49406 (CEA-CONF–1787) COMPATIBILITY OF FERRITIC STEELS WITH LIQUID SODIUM AT HIGH TEMPERATURES. Sannier, J.; Konovaltschikoff, O.; Leclercq, D.; Darras, R. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1971. 16p. (CONF-710713–1). Dep. NTIS (U. S. Sales Only).

From International conference on the effects of environment on materials properties in nuclear systems; London, England (1 Jul 1971).

The long term behavior, in liquid sodium at temperatures between 475 and 650°C, of various ferritic steels containing 2.25 or 9% chromium is compared with that of mild or austenitic steels. At 475°C, stabilized or unstabilized ferritic steels are practically unaffected, whereas mild steels are heavily decarburized. At 650°C, unstabilized 2.25% chromium steel shows a considerable decarburization; this phenomenon does not affect 9% chromium steel, which presents a weight loss lower than 0.5 $mg.cm^{-2}$ after 6000 hours, similar to that of austenitic steels. (auth) (France)

49407 (COO–916-20) STRUCTURE AND PROPERTIES OF SOLID SOLUTIONS. Technical Progress Report, September 1, 1970–June 15, 1971. Koss, D. A.; Hendrickson, A. A. (Michigan Technological Univ., Houghton. Dept. of Metallurgical Engineering). Contract AT(11-1)-916. 14p. Dep. NTIS.

Results of research on the nature of solid solution strengthening in fcc and bcc substitutional alloys are reported. The research is concerned with both an analysis of individual dislocation-defect interactions and the relation between dislocation behavior and macroscopic mechanical properties. Yield stress and stress-strain behavior of very pure substitutional alloy single crystals were investigated and observations of the motion and interaction of individual dislocations were made using etch pitting techniques. The results serve as a basis for understanding the mechanisms of solid solution hardening as well as serving as critical tests of current hardening theories. (J.R.D.)

49408 (N–70-37044) MONOTONIC AND CYCLIC MECHANICAL RESPONSE OF THE Ni–Ni_3Nb EUTECTIC COMPOSITE. Hoover, William R. (Lehigh Univ., Bethlehem, Pa. Dept. of Metallurgy and Materials Science). 1970. 68p. (NASA-CR–112772). NTIS.

Thesis.

The static and dynamic mechanical behavior of the Ni-Ni_3Nb eutectic composite was studied with tensile, compressive, and fatigue testing, and metallography and electron fractography. A study of the deformation and fracture behavior of the Ni_3Nb phase was also conducted. The Ni_3Nb phase was found to deform primarily by twinning with little or no slip. Room temperature tensile testing of the eutectic composite produced uniform tensile strains in excess of 11%. Tension-tension fatigue studies of the eutectic alloy were conducted. The composite displayed excellent fatigue resistance in a notched configuration by exhibiting an apparent endurance limit of about 55% of the 108 ksi smooth bar tensile strength. The fatigue behavior of the Ni-Ni_3Nb eutectic composite was compared with that of Al-Al_3Ni eutectic composite,

and similar operative crack growth mechanisms were found. (auth) (STAR)

49409 (N-71-16498) EXPERIMENTAL BIAXIAL CREEP DATA FOR TANTALUM, MOLYBDENUM, AND ALLOYS T-111, TZM, AND TZC. Maag, William L.; Mattson, William F. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb 1971. 26p. (NASA-TN-D-6149; E-5822). NTIS.

Experimental, biaxial steady-state creep data for tantalum, T-111, molybdenum, TZM, and TZC are presented. The tests were conducted on internally pressurized thin-wall tubes. The biaxial creep data were analyzed using the von Mises criterion for plastic flow. The data, in terms of effective stresses and strain rates, were compared with uniaxial data of other investigators and the results were equivalent. Creep-rate correlations for each material are presented. (auth) (STAR)

49410 (ORNL-TM-3300, pp 224-6) CLADDING MATERIALS FOR SPACE ISOTOPIC HEAT SOURCES. Patriarca, P.; Donnelly, R. G. (Oak Ridge National Lab., Tenn.).

New cladding materials are being developed for containment of radioisotopes in power systems for use in space. It was found that adding 1% Hf to the Pt-5% Mo alloy improved tensile strength at both room temperature and elevated temperatures without impairing the ductility. Alloys in the Pt-Rh-W and Pt-Rh-Re systems and modifications of those that contain additions of Hf, Zr, or Ti are also being investigated for fabricability, melting point, air oxidation, compatibility, mechanical properties, and weldability. (auth)

49411 (ORNL-TM-3300, pp 227-44) PHYSICAL AND MECHANICAL METALLURGY OF REFRACTORY ALLOYS. Patriarca, P.; Donnelly, R. G. (Oak Ridge National Lab., Tenn.).

The time required to produce 1% creep strain in T-111 in a 1×10^{-6} torr pressure of N_2 at 1400°C was found to be about one-third of that required to produce the same strain in ultrahigh vacuum, and the rupture life was about one-eighth of that in vacuum. A method was devised for determining the solubility limit of O in T-111, and equipment was set up to prepare specimens. The development of age-hardening refractory alloys continued. The aging responses of Ta-Hf and Ta-Zr alloys were determined by both hardness and tensile testing. Yield strengths over 300,000 psi were obtained with the Ta-65% Hf alloy. Stress-rupture tests on T-222 welds showed rupture times to be equal to those of unwelded material at low stresses but shorter at high stresses. Long-time stress-rupture data were also obtained on the Nb alloy SU-16. This is the strongest Nb-based alloy tested in the program. Welding activities included the completion of a Mo thermal convection loop, studies into the morphology of fractures in Mo tubing, and similar studies of welds in Mo alloys. Studies on brazes of refractory alloys were continued on the mechanisms controlling the remelting temperature. Studies of low lattice thermal conductivity of Mo are awaiting improvements to the sensitivity of the longitudinal heat flow apparatus. (auth)

49412 (ORNL-TM-3416, pp 192-206) PHYSICAL AND MECHANICAL METALLURGY OF REFRACTORY ALLOYS. (Oak Ridge National Lab., Tenn.).

In fuels and materials development program quarterly progress report for period ending March 31, 1971.

The pressure-temperature-composition relationships in the nitrogen/T-111 system have been determined in the range of 1200 to 1600°C. Nitrogen partial pressures were higher than those reported for unalloyed tantalum. Creep tests of T-111 at 1400°C in low partial pressures of nitrogen, such as those expected from UN fuels, resulted in moderate strengthening. No emissivity differences were detected in tests run in nitrogen or vacuum indicating that a nitride film does not form on the T-111 surface. The effect of oxygen on the tensile properties of T-111 was determined for use in research on plutonium-238 oxide fueled space isotope heat sources. Oxidized samples given a 15-min, 1700°C reentry-type heat treatment, exhibited moderate reductions in ductility and increases in strength up to about 220 ppM. Both strength and ductility were nearly independent of oxygen content from 200 to 2800 ppM. In contrast, as-oxidized specimens containing 800 ppM oxygen fractured in a brittle manner at temperatures as high as 1316°C. The stress-rupture behavior of longitudinal GTA welds in Ta-10% W was compared with unwelded control specimens, transverse GTA welds, and transverse EB welds. The creep behavior of the niobium alloy SU-31 was also determined. Scanning electron microprobe analysis of fractures in TZM welds revealed modest amounts of oxygen in hot-cracked areas but none in cold-cracked areas. Repairs to a damaged molybdenum corrosion loop were made by welding on T-111 components using Mo-46% Re filler. Samples of Mo-Zr and Mo-Nb alloys have been obtained and characterized in preparation for determining the lattice thermal conductivity of molybdenum. Electrical resistivity measurements on Mo-ThO_2 cermet isotope fuel simulants showed the material produced by chemically vapor depositing the molybdenum to be a better conductor than one produced by blending molybdenum and thoria powders. (auth)

49413 (RD/B/N-1874) NOVEL METHOD FOR THE DETERMINATION OF THE SOLUBILITY OF SOLUTES IN LIQUID METALS. THE SOLUBILITY OF ANTIMONY IN SODIUM FROM 190-550°C. Evans, H. E.; Watson, W. R. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Feb 1971. 18p. Dep. NTIS (U. S. Sales Only).

A method suitable for the determination of the solubilities of single or mixed solutes in liquid metals has been developed and used for the determination of the solubility of antimony in sodium. By monitoring the distribution of a known amount of radioactive material in a sealed capsule containing the liquid metal and comparing the activity in regions of the capsule with and without an adsorber foil, the percentage of the solute actually in solution can be determined. Thus the solubility at various temperatures can be estimated. The method avoids errors due to sampling difficulties, particulates in suspension, and failure to attain equilibrium which have vitiated much earlier work. The solubility of antimony from 190° to 550°C was found to be given by the expression $\log_{10} S_{(Sb)}$ ppM = (8.662 ± 0.007) − (3.943 ± 0.023) × 1/T. This leads to values of 18.04 ± 0.10 kcal/mole and −29.0 ± 6.1 kcal/mole for the partial molal heats of solution of Na_3Sb and Sb in sodium. Evidence of reversible adsorption of antimony on stainless steel in liquid sodium was obtained. (auth)

49414 (RT/MET-(70)4) FABRICATION OF CONTROL RODS. Dalmastri, B.; Fizzotti, C.; Lo Tenero, B. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 21 Mar 1970. 24p. (In Italian). Dep. NTIS (U. S. Sales Only).

Techniques employed for the fabrication of control rods were investigated and discussed. Two types of control rods were fabricated: metallic (Ag-In-Cd) rods and ceramic (B_4C) rods. Metallic rods were prepared by casting, swaging, and canning in stainless steel. Ceramic rods were prepared by vibrational compacting the B_4C powder in stainless steel cans. (auth)

49415 (UJV-2505-M) MECHANICAL PROPERTIES OF URANIUM AND ITS ALLOYS IN THE RANGE 350 TO 640°C. Influence of Speed of Deformation. Saxl, I. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Mar 1971. 39p. (In Czech). Dep. NTIS (U. S. Sales Only).

The effect of deformation rate, $\Sigma \sim (1.6 \times 10^{-4} - 1.6)\text{min}^{-1}$, on mechanical properties of extruded, γ-quenched and α-annealed technical purity uranium and its alloys with aluminum (800 to 900 ppM), iron (350 ppM) and silicon (350 ppM) is measured in the temperature range 350 to 640°C. Higher strain rate increases both the yield stress and ultimate tensile strength; the higher the temperature the more pronounced is the effect. The elongation is affected by deformation rate only at higher temperatures (550 to 640°C). The close connection between strain rate sensitivity and nonuniform elongation is demonstrated, their mutual relation is independent on testing conditions and composition. Mechanical properties of argon-quenched and water-quenched uranium alloys are briefly compared. (auth)

49416 MICROYIELDING AND FLOW IN NIOBIUM ALLOY CRYSTALS. Wilson, Frank Graham. Vancouver, British Columbia; Univ. of British Columbia (1970). National Library of Canada, Ottawa.

Thesis.

Oriented single crystals of niobium and dilute alloys with molybdenum and tantalum were deformed in tension between 77 and 500°K, and the macroflow and slip parameters established. At high temperatures the main effect of alloying was to increase the flow stress, considerably more with molybdenum than with tantalum. The observed yield drop and subsequent plastic flow were explained in terms of a stability theory relating changes in yield and work hardening parameters with temperature and addition of solute. A technique was developed for measuring small plastic strains in the microflow region, and for recording the dynamic transition to macroflow. From studies on pure niobium between 77 and 295°K, the nature of dislocation motion at small strains was established; microflow was explained in terms of a transition from edge dislocation motion to screw dislocation motion at the macroflow stress. Interstitial effects were found to be particularly significant during microflow, and are probably important in determining the low temperature flow stress in even the highest purity bcc metals. A further low temperature contribution comes from a directional component of the internal

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stress field which depends on the distribution of dislocations rather than on their density. Microflow curves were obtained for niobium alloy crystals, and the interaction of dislocations with substitutional solute atoms established. In contradiction to previous suggestions, substitutional solute was found to restrict the mobility rather than the multiplication of dislocations. The elastic contribution of solute atoms to the internal stress field was confirmed, although a quantitative theory for bcc alloys does not exist. Peierls stress considerations alone were found to be incapable of explaining either the temperature sensitivity of flow or the low temperature solution softening; the short range interaction of interstitials with the dislocation core was considered to be more significant. (Diss. Abstr. Int., B)

49417 CONTRIBUTION TO THE THERMODYNAMICS OF INTERSTITIAL SOLID SOLUTIONS. Wagner, C. (Max-Planck-Institut fuer Physikalische Chemie, Goettingen, Ger.). Acta Met.; 19: No. 8, 843-9(Aug 1971).

Upon dissolution of hydrogen, boron, or carbon in Pd or Fe as host metal at constant pressure, the lattice spacing increases. Thus the accommodation of H, B, or C atoms on interstitial sites is facilitated. For an interpretation of experimental activity data as a function of concentration in conjunction with special models accounting for pair interaction of solute atoms and electronic constitution, it is expedient to consider activity data at constant volume, i.e. constant lattice spacing rather than constant pressure. Analogous considerations apply to changes in the solubility of hydrogen in Pd upon adding alloying elements such as B, Ag, Sn, Pd, Rh or Ni. (auth)

49418 STRUCTURE AND PROPERTY CONTROL THROUGH RAPID QUENCHING OF LIQUID METALS AND ALLOYS. Grant, Nicholas J. (Massachusetts Inst. of Tech., Cambridge). Fizika (Zagreb); 2: Suppl. 2, 16.1-15(1970).

From International conference on metastable metallic alloys; Brela, Yugoslavia (28 Sep 1970). See CONF-700952.

It was demonstrated that the potential for control of structure by rapid quenching of the liquid melt is an ideal way of minimizing segregation, eliminating the formation of coarse secondary phases (both desired and undesired phases), and achieving fine grain size. There is an immediate major improvement in hot and cold plasticity which permits forging and rolling of otherwise non-forgeable alloys, or increases forgeability by an order of magnitude. Low and intermediate temperature properties are increased by large proportions, and large fatigue life benefits are achieved. If high-temperature properties are desired, the fine grain structure must be coarsened; however, this usually occurs without the simultaneous coarsening of most of the excess phase particles. To accomplish grain coarsening, the oxygen content must be reasonably low, for example, 200 ppM in nickel or cobalt-base superalloys. The use of both fine and coarse powders, provided the quench rates are adequately high, will show the desired degree of structural refinement. A number of techniques are available for consolidation of the powders into ingot compacts, bloom, billets, slabs, and perhaps preforms for direct conversion to finished shapes. In a number of alloy systems totally new compositions will result, with unusual combinations of alloying elements and phases which cannot possibly be combined in metal processes where slow solidification takes place. Perhaps for the first time, major control of structure and properties is now possible, with promise for future developments. (auth)

49419 THERMAL DECOMPOSITION OF QUENCHED URANIUM-RICH BINARY ALLOYS. Lazarevic, Dj.; Gligic, M. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Fizika (Zagreb); 2: Suppl. 2, 44.1-6(1970).

From International conference on metastable metallic alloys; Brela, Yugoslavia (28 Sep 1970). See CONF-700952.

Some results of a study by the resistivity method of thermal decomposition of quenched binary uranium alloys with small additions of silicon, iron and aluminum are presented. These results were related to the solute ionic radius. (auth)

49420 ACTIVATION VOLUME FOR SELF DIFFUSION IN THE ϵ PHASE OF PLUTONIUM. Cornet, J. A. (CEN, Fontenay-aux-Roses, France). J. Phys. Chem. Solids; 32: No. 7, 1489-1506 (Jul 1971). (In French).

An experimental device is described which allows one to obtain hydrostatic pressures in the range 0 to 20 kbars at temperatures up to 1000°C; it was used for the study of self diffusion under pressure in the bcc ϵ phase of plutonium. Only a few experimental results were obtained, but they indicate that the rate of self-diffusion in that phase increases under pressure: activation volume for self-diffusion is negative ($\Delta V = -4.9$ cm^3, i.e., -33.6% of the molar volume). The correlations generally used do not preclude such a result, but it does not seem to be consistent with a diffusion vacancy mechanism. The possibility of an interstitial mechanism is discussed. (auth) (UK)

49421 INFLUENCE OF TEMPERATURE ON SLIP BEHAVIOR OF MOLYBDENUM SINGLE CRYSTALS DEFORMED IN TENSION IN THE RANGE FROM 293 TO 573^{0}K. II. SLIP GEOMETRY AND STRUCTURE OF SLIP BANDS. Richter, J. (Deutsche Akademie der Wissenschafte, Berlin. Institutsteil fuer Metallphysik und Reinstmetalle, Dresden). Phys. Status Solidi (b); 46: No. 1, 203-15(1 Jul 1971).

The slip line pattern of molybdenum single crystals deformed in tension at temperatures between 293 and 573°K ($T/T_m = 0.1$ to 0.2) was systematically investigated using optical and electron microscopy. The transition from parabolic stress–strain behavior to three-stage hardening which occurs in a transition range $T_t \approx 340$ to 400°K is associated with a basic change in the slip line pattern. At temperatures $T < T_t$ multiple slip occurs, whereas for $T > T_t$ single slip in stage I is characteristic. For $T > T_t$ the slip lines are pronounced wavy or zigzag-like, indicating that at elevated temperatures cross-slip is an important slip process. Furthermore, composite slip on nonparallel {110} planes was found at temperatures $T > T_t$. The observations suggest that the influence of temperature on slip line pattern results from the strong increase of mobility of screw dislocations with increasing temperature. (auth)

49422 TRANSIENT CREEP OF Cd+Mg ALLOY SINGLE CRYSTALS. Stejskalova, V. (Purkyne Univ., Brno). Phys. Status Solidi (b); 46: No. 1, K43-6(1 Jul 1971).

The exponent m for the shear strain rate dependence on time, the activation volume, and the velocity-stress exponent n were measured on single crystals of Cd containing 0.01 and 0.1 at. % Mg at 295°K. The dependences on the resolved shear stress show that the exponents increase with the Mg content, and that the activation volume decreases as $V \sim \tau^{-1}$ and increases with Mg content. (D.L.C.)

49423 SIMULTANEOUS ADSORPTION OF HYDROGEN AND CARBON MONOXIDE ON TUNGSTEN. Ustinov, Yu. K. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 2, 447-52(Aug 1971).

Translated from Fiz. Tverd. Tela; 13: No. 2, 558-61(Feb 1971).

Adsorbed layers were investigated simultaneously by electron field-emission and flash methods. Such investigations gave new information on the nature of the surface coverage of various crystallographic faces, on the localization of the adsorbate at various substrate temperatures, on the dimensions and migration of adsorbed layers during heating, and on the mechanisms of simultaneous adsorption of different particles. The simultaneous chemisorption of hydrogen and carbon monoxide on tungsten was investigated by means of an electron field-emission projector and by the flash method in a time-of-flight mass spectrometer. (auth)

49424 TOUGHNESS OF STEEL PLATES FOR REACTOR PRESSURE VESSELS. Susukida, H. (Mitsubishi Heavy Industries, Ltd., Kobe, Japan). Kinzoku Zairyo; 10: No. 11, 17-23 (Nov 1970). (In Japanese).

With the increase in power output of light-water power reactors, the thickness of steel plates used for pressure vessels is increasing. Standards for the steel plates associated with nuclear application are reviewed. Tests of the toughness using wedge-opening loading and dynamic tear techniques are discussed. Plate-thickness effects are discussed showing that the increase of plate thickness with increasing power of reactors adversely affects the toughness. The relations of plate thickness and NDT temperature are shown. Alloying elements and heat treatment are connected with hardenability; PV manufacturers are responsible for the heat treatment. Neutron irradiation increases strength, however, ductility and toughness are lowered. (Japan)

49425 MECHANICAL BEHAVIOR OF BCC METALS UNDER HYDROSTATIC PRESSURE. Daga, Raman Lall. Cleveland; Case Western Reserve Univ. (1970). 134p. University Microfilms Order No. 71-18,983.

Thesis.

The effects of hydrostatic pressure on the mechanical behavior of two group VIA bcc elements, viz., tungsten (polycrystalline arc-melted) and chromium (polycrystalline iodide) have been investigated at room temperature. Tensile stress-strain behavior at room temperature and constant strain rate for these two metals have been studied as a function of environmental hydrostatic pressure and response to pressurization. The modes of deformation and fracture characteristics were studied by optical microscopy and scanning electron microscopy, and the associated changes in the substructures examined by transmission electron microscopy.

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In the case of tungsten, increase in pressure does not appear to affect the plastic yielding and earlier stage of deformation, but the strain to fracture increases continuously with pressure. The fracture stress remains approximately constant up to 5 kilobars, beyond which it increases significantly. In the latter region, a change in fracture mode from transgranular cleavage to intergranular separation with increasing pressure occurs. The effect of pressure on the mechanical properties of chromium is more pronounced. At 2 kilobars, a discontinuous increase in ductility and an abnormal plastic yielding (load drop after 3% plastic strain) are observed. In contrast, the effect of pressurization in this material was very small. The dislocation substructures in both metals when deformed under pressure have been observed to be different than when deformed at ambient conditions. In the case of fracture the results for both these metals point to limitations of present theories on the effects of hydrostatic pressure on cleavage fractures. A model to explain some of the differences of the theories from the observations is proposed which considers the effects of pressure on nucleation of a cleavage crack. (Diss. Abstr. Int., B)

49426 HARDNESS METHOD FOR DETECTING THE TRANSITION OF BRITTLENESS OF STEELS AND ITS APPLICATION. Sato, Sennosuke (Ibaraki Univ., Hitachi, Japan); Imamura, Yoshio; Oku, Tatsuo. Nippon Kikai Gakkaishi; 73: No. 622, 1490-9(Nov 1970). (In Japanese).

An attempt to measure transition points of brittleness was made on the basis that hardness changes sharply at the ductility transition temperature in body-centered-cubic metals. The transition temperature of Vickers hardness was determined and compared with tensile properties and Charpy impact fracture processes for several kinds of steels for pressure vessels and structures. From the point of view of the fracture mechanism, it was shown that higher first transition temperature and lower second transition temperature of the hardness correspond to the ductility transition temperature T_d and the brittleness transition temperature T_b respectively. This method was applied to the following examples to detect the transition of brittleness: combined effect of heat and prestrain in welded materials; effect of repeated stresses on rise of the transition temperature; and measurement of the brittleness transition of materials irradiated with in-pile neutrons. As a result, this method was confirmed to be useful. (Japan)

49427 CALORIMETRIC HEATS OF CHEMISORPTION OF NITROGEN ON TUNGSTEN AT HIGHER TEMPERATURES. Yamazaki, Hisashi; Oguri, Takeo; Kanomata, Ichiro (Tokyo Metropolitan Univ.). Jap. J. Appl. Phys.; 10: No. 8, 1105 (Aug 1971).

In order to obtain the calorimetric heat of the β_2 state alone in the chemisorption of N_2 on W, measurements were carried out at higher temperatures (300 to 1300°K) and lower coverages ($\frac{1}{3}$ of a monolayer). A variation of E_H with temperature, with a minimum of ~2 eV at 450°K and a maximum of 6 to 7 eV at 700°K, suggests that the β_2 state is not a single state but two substates. (D.L.C.)

49428 MERCURY AS A NUCLEAR COOLANT. Fleitman, A. H.; Weeks, J. R. (Brookhaven National Lab., Upton, N. Y.). Nucl. Eng. Des.; 16: No. 3, 266-78(Jul 1971).

A review is given of the following properties of Hg: neutron cross sections of Hg isotopes, physical properties, chemistry, handling, corrosion of structural materials by liquid and boiling Hg, and corrosion inhibition. 49 references. (D.L.C.)

49429 ZIRCONIUM PRECIPITATION IN THE FORM OF INTERMETALLIC NICKEL–ZIRCONIUM COMPOUNDS BY NICKEL DIFFUSION IN A MAGNESIUM–ZIRCONIUM ALLOY. Pegoud, Joseph; Guillaumin, Jean (SICN, Veurey, France). Compt. Rend., Ser. C; 272: No. 22, 1792-5(2 Jun 1971). (In French).

The effects of nickel diffusion in a 0.5% Mg–Zr alloy were studied using microscopy, electron microscopy, and microdiffraction. Zirconium hydride precipitates are not affected by nickel diffusion, whereas dissolved zirconium becomes insoluble in the form of thin intermetallic compound particles such as: Ni_5Zr, Ni_5Zr_2, $Ni_{10}Zr_7$, NiZr, or $NiZr_2$. (France)

49430 ADSORPTION KINETICS OF OXYGEN AT THE SURFACE OF SINGLE NIOBIUM CRYSTALS AT HIGH TEMPERATURES AND LOW PRESSURES. Simon, Dominique; Bardolle, Jean (Univ., Orleans, France. CNRS, Orleans-la-Source, France). Compt. Rend., Ser. C; 272: No. 22, 1800-3(2 Jun 1971). (In French).

The adsorption of oxygen by single niobium crystals was studied at high temperatures (525–960°C) and low oxygen pressure (6×10^{-5} torr). The results obtained with the (111), (110), and (100) faces demonstrate discrepancies between the adsorption rates at these faces. The reaction kinetics were found to be linear with two activation energies for each orientation: 3 kcal/mole at high temperatures and between 45 and 15 kcal/mole at a lower temperature. An interpretation of these results is proposed. (France)

49431 DIFFUSION SATURATION OF SPHERICAL REFRACTORY METALS POWDERS WITH CARBON AND BORON. Krasnov, A. N.; Burikina, A. L. (Inst. of Problem in Materials, Kiev). Rev. Int. Hautes Temp. Refract.; 8: No. 1, 15-24(Jan-Mar 1971).

Using the known diffusion constants, the saturation times at different temperatures were determined for surfaces composed of spherical grains of tungsten, molybdenum, and niobium. The thickness of the carbide or boride surface layer was evaluated in certain cases. The carbonization and boronization processes were investigated using the calculated data and information was deduced about the formation of the coating formed on the spherical metal grains. Metallographic and x-ray analysis gave results which were in good agreement with those predicted theoretically. (France)

49432 PRESTRESSED CONCRETE STEELS USED FOR NUCLEAR REACTORS. Tani, Yoshio (Kobe Steel, Ltd., Japan). FAPIG (Tokyo); No. 55, 183-7(Dec 1969). (In Japanese).

A study team was sent to European countries and the United States from June 28 to July 28, 1969 to evaluate the use of prestressed concrete (PC) steels used for nuclear reactor systems. The specifications of such PC steels, especially for prestressed concrete pressure vessels, and the views held toward their use, are explained. The methods of construction with PC steel, and the particular PC steel employed, are varied, and the development studies in the field are also extensive. The most common employment and development, however, is PC steel wires with a small stress relaxation at low temperature, e.g., stabilized PC wires. The following are described: reactor use of PC steels in UK; stabilized PC wires and neutron-irradiation effects on PC steels; the state and views held, concerning the PC steels, in Germany, Switzerland, and France; and PC steels in the United States, including those in the Ft. St Vrain reactor and other reactors. (Japan)

49433 DEFORMATION STRESS STATE EFFECTS ON THE RECRYSTALLIZATION KINETICS OF MOLYBDENUM. Barto, R. L.: (General Electric Co., Cleveland); Ebert, L. J. Met. Trans.; 2: No. 6, 1643-9(Jun 1971).

Results of studies of the recrystallization characteristics of cold worked pure molybdenum indicated a dependence upon the mode of deformation and a definite dependence on the manner used to describe the deformation. On the basis of a constant amount of deformation strain, molybdenum deformed in pure compression exhibited slower rates of recrystallization, higher activation energies and coarser grain sizes than that deformed in simple tension. Deformation by rolling protraced recrystallization effects resembling those of compression, while straining by drawing resulted in rates similar to those of tension. (auth)

49434 CREEP AND DURABLE STRENGTH OF MOLYBDENUM AT HIGH TEMPERATURES. Zelenyuk, E. E.; Krivenyuk, V. V. Probl. Prochnosti; No. 11, 86-90(Nov 1970). (In Russian).

Results are given for a series of investigations on the creep and protracted durability of molybdenum at 1,000°C over a range of 0.1 to 400 hr, and at temperatures of 1,200, 1,400, 1,600, and 1,800°C over the range from 01. to 100 hr. The data established the thermal dependence of the durability, the time dependence of the durability, and the creep rate. Qualitative analyses were conducted on the influence of the hot brittleness of molybdenum on the uniformity of creep and the protracted durability. (tr-auth)

49435 THERMOMECHANICAL PROPERTIES OF A TANTALUM–TUNGSTEN–HAFNIUM ALLOY (Ta-222) AT 20 TO 1800°C: EFFECT OF Si–Ti PROTECTIVE COATING. Bollenrath, F. M. (Technische Hochschule, Aachen); Lovelace, A. M. High Temp. - High Pressure; 2: No. 5, 521-6(1970). (In German).

Thermomechanical properties of a tantalum–tungsten–hafnium alloy were studied in the temperature range 20 to 1800°C. 1-mm-thick sheet specimens were subjected to tensile tests at different strain rates. Uncoated tensile test specimens were heated in a vacuum by radiation, and specimens with an Si–Ti coating, protecting them against oxidation, were heated in air by induction heating. The room-temperature Vickers hardness was determined before and after the tensile tests and the high-temperature Vickers hardness was obtained from pendulum indentations produced in a vacuum. The chemical analysis of the coating and of the substratum was carried out with an electron microprobe and the structure was examined microscopically. The coated test specimens became

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brittle at temperatures around 1000°C. The tensile strength of the coated specimens at 20°C was 16% lower, and at 1000°C 40% lower, than that of the uncoated specimens. (auth) (UK)

49436 DIFFUSION IN METALLISCHEN WERKSTOFFEN. (Diffusion in Metallic Materials). Conference Held at Dresden, Germany, April 1–2, 1970. Leipzig; VEB Deutscher Verlag fuer Grundstoffindustrie (1970). 328p. (In German and English). (CONF-700436).

A total of 18 papers were presented at the conference. A separate abstract was prepared for each of 9 papers. The remaining 9 papers were not within the scope of NSA. (G.M.C.)

For abstracts of individual papers see: 49365, 49437–49442, 49496, and 49520.

49437 GRAIN BOUNDARY DIFFUSION IN METALS. Haessner, A. (Bergakademie, Freiburg i. B.). pp 41-73 of Diffusion in Metallischen Werkstoffen. Leipzig; VEB Deutscher Verlag fuer Grundstoffindustrie (1970). (In German).

From seventh metal meeting; Dresden, Germany (1 Apr 1970). See CONF-700436.

The problems to be worked out in the understanding of grain boundary diffusion are reviewed. The phenomenological description of diffusion in metals with grain boundaries is given. The most significant experimental results on grain boundary diffusion in pure metals were summarized for polycrystalline and bicrystalline samples. The effect of trace and alloying elements on the diffusion is considered. (J.S.R.)

49438 DIFFUSION OF INTERSITITIAL IMPURITIES IN METALS. Koethe, A.; Schlaet, F. (Institutsteil fuer Metallphysik und Reinstmetalle, Dresden). pp 89-127 of Diffusion in Metallischen Werkstoffen. Leipzig; VEB Deutscher Verlag fuer Grundstoffindustrie (1970). (In German).

From seventh metal meeting; Dresden, Germany (1 Apr 1970). See CONF-700436.

The diffusion of interstitial impurities in cubic body-centered metals is considered. The geometric aspects of the introduction of interstitial impurities into the metallic lattice are discussed. The calculation of the frequency factor D_0 and the activation energy Q is described. The significance of the observed deviations from the Arrhenius law is discussed. Methods for the determination of the diffusion coefficients of interstitial impurities are summarized. The diffusion-dependent interaction of impurities with dislocations is considered. The diffusion in external fields is also considered. The peculiarities of interstitial impurities in special systems are briefly discussed. (J.S.R.)

49439 MULTIPHASE DIFFUSION. Heumann, Th. (Univ., Muenster, Ger.). pp 129-42 of Diffusion in Metallischen Werkstoffen. Leipzig; VEB Deutscher Verlag fuer Grundstoffindustrie (1970). (In German).

From seventh metal meeting; Dresden, Germany (1 Apr 1970). See CONF-700436.

A review is given of the present state of knowledge of multiphase diffusion. The ideal diffusion system, seed formation and growth, equilibrium phases and equilibrium concentrations, effect of external pressure, and transposition mechanisms are discussed. In the discussion of the effect of external pressure U and Cu are considered. (J.S.R.)

49440 ISOTOPE EFFECTS AND CORRELATION IN DIFFUSION IN METALS. Le Claire, A. D. (Atomic Energy Research Establishment, Harwell, Eng.). pp 143-60 of Diffusion in Metallischen Werkstoffen. Leipzig; VEB Deutscher Verlag fuer Grundstoffindustrie (1970).

From seventh metal meeting; Dresden, Germany (1 Apr 1970). See CONF-700436.

A description is given of how the mass of a diffusing atom affects its diffusion coefficient and then expressions are derived for the isotope effect for some of the simpler cases met with in practice. After describing the essential features of the experimental technique commonly employed some of the results that were obtained are discussed, so as to illustrate the use that can be made of them in elucidating some of the details of diffusion processes in metals. It can be seen that measurements of the isotope effect in diffusion in solids can be most informative. Because of its dependence on the correlation factor they can provide a useful confirmation in many cases of the mechanism of diffusion that is operating; they may be especially valuable in the future in helping to establish mechanisms in the more unfamiliar and less studied systems. In impurity diffusion, where the mechanism of diffusion is usually known, so that the appropriate correlation factor can be used in analyzing the results, they provide valuable information on relative jump frequencies of solute and solvent species. Of special interest is the values they can provide of the quantity ΔK, for this contains important and significant information on the dynamics of atom jump processes that is not readily available by other methods. Such information is only beginning to be made use of in furthering an understanding of diffusion in solids; the case of Na illustrates how decisive and searching a role it may play. (auth)

49441 DIFFUSION AT HIGH PRESSURES. Kedves, F. J. (Kossuth Univ., Debrecen, Hungary). pp 191-205 of Diffusion in Metallischen Werkstoffen. Leipzig; VEB Deutscher Verlag fuer Grundstoffindustrie (1970). (In German).

From seventh metal meeting; Dresden, Germany (1 Apr 1970). See CONF-700436.

A brief review is given of the theory of the thermally activated process. Some typical experimental results in the study of diffusion at high pressures were given. The experimental and theoretical results were compared. (J.S.R.)

49442 DIFFUSION PROCESSES IN THE TUNGSTEN–RHENIUM SYSTEM. Staudt, J.; Kaiser, H. (VEB Kombinat Narva, Berlin). pp 271-8 of Diffusion in Metallischen Werkstoffen. Leipzig; VEB Deutscher Verlag fuer Grundstoffindustrie (1970). (In German).

From seventh metal meeting; Dresden, Germany (1 Apr 1970). See CONF-700436.

The results of extensive studies made on the determination of multiphase growth of both the intermetallic phases and the mixed crystal range in rhenium-containing tungsten were reported. The phase growth was determined at temperatures from 1600 to 2000°C. The present experimental results were compared with those obtained by other investigators. (J.S.R.)

49443 FERRITIC Cr–Mo STEEL WITH NIOBIUM ADDITIONS FOR INCORPORATION INTO THE STRUCTURES OF SODIUM-COOLED NUCLEAR REACTORS. Lorenz, Klaus; Kranz, Eckhard; Fabritius, Heinz. Energ. Tech.; 23: No. 2, 38-42(1971). (In German).

In sodium-cooled reactors, carbon transport from ferritic to austenitic structural components must be prevented. Systematic diffusion experiments showed that the addition of niobium and titanium to steel completely binds carbon, while vanadium fails to do so. In niobium-containing steel, which was extensively studied, carbon and nitrogen are bound as niobium carbonitrate. Properties of such steel were tested as to temperature behavior, ductility, and welding. Addition of 0.6% nickel improved notch resistance noticeably. (H.B.G.)

49444 APPLICATIONS OF MODERN METALLOGRAPHIC TECHNIQUES. Symposium Presented at the Materials Engineering Exposition and Congress, American Society for Metals, Philadelphia, Pa., 13–16 Oct. 1969. ASTM Special Technical Publication 480. Philadelphia; American Society for Testing and Materials (1970). 277p. $17.00. (ASTM-STP-480; CONF-691064).

The ten papers published in the proceedings of this conference describe new or improved applications of some of the most up-to-date methods in metallography. Some of the methods discussed are: electron microscopy, electron microprobe analysis, x-ray microscopy and analysis, manual and electronic quantitative metallography, high-speed dilatometry, special etching and optical techniques for improved color metallography, and preparation and examination of irradiated materials. No separate abstracts have been prepared. (B.L.M.)

49445 SOLUBILITY OF BORON IN A Mo–W SOLID SOLUTION AND THE PROPERTIES OF THE ALLOYS. Kharitonov, V. I.; Shamrai, F. I.; Fedotov, S. G.; Tkachev, L. G. (Inst. of Metallurgy, Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 2, 201-3(Feb 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 2, 228-30(Feb 1971).

The results of a study of the solubility of boron in an Mo–W solid solution, and the properties (modulus of elasticity, hardness, resistivity, and long-term strength) of the alloys are presented. (auth)

49446 PLASTIC DEFORMATION AND FRACTURE OF CASTED ROLLED BERYLLIUM UNDER HYDROSTATIC PRESSURE LOWER THAN 15 KBAR. Bedere, D.; Jamard, C.; Jarlaud, A.; Francois, D. (CEA, Bruyeres-le-Chatel, France). Acta Met.; 19: No. 9, 973-83(Sep 1971). (In French).

Lower than 15 kbar hydrostatic pressure effect on mechanical properties (plastic behavior and fracture) of cast rolled beryllium gage specimens strained by tension parallel and perpendicular to the rolling direction was analyzed. Room temperature and constant strain rate tests were carried out. Load and lengthening of gage specimens were directly measured. Furthermore, metallography

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and electronic microscopy studies were made. Plastic behavior was not affected by pressure, but fracture lengthening and load increased, leading to a partial striction. Evidence of (c + a) slip could not be established, but probably such a slip exists in regions where strain concentration is high. Fracture begins by an intragranular cracking. Then a cleavage cracking occurs, giving a suitable theory verification. At high pressures, ductile shear fracture occurs and leads to a larger ductility: ductility is directly proportional to the cold work coefficient. (auth)

49447 WETTING OF TUNGSTEN AND MOLYBDENUM BY MELTS BASED ON POTASSIUM, SILICON, AND ALUMINUM OXIDES. Amosov, V. M.; Marenkina, L. V.; Mitin, B. S.; Mozzhukhin, E. I.; Turgenev, I. S. (Inst. of Steel and Alloys, Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 2, 292-3 (Feb 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 2, 330-2(Feb 1971).

Wetting of W and Mo by complete oxides in the systems K_2O-SiO_2 and $K_2O-SiO_2-Al_2O_3$ was investigated. Resulting data are presented on W and Mo angles of contact in relation to temperature and silicon content. (J.R.D.)

49448 OMEGA PHASE EMBRITTLEMENT IN AGED Ti–15 PERCENT Mo. Bowen, A. W. (Royal Aircraft Establishment, Farnborough, Eng.). Scr. Met.; 5: No. 8, 709-15(Aug 1971).

Tensile tests were conducted on Ti–15 Mo (16.25 wt % Mo) specimens quenched from 800°C and aged under varying conditions to obtain varying α, β, and ω proportions. The ω phase was found to increase the tensile strength, and load–elongation curves were obtained. Metallographic examination of the deformed and fracture surfaces was also done. The role played by the ω phase in strengthening β-titanium alloys is discussed. (D.L.C.)

49449 YIELD POINT PHENOMENA IN METALS AND ALLOYS. Hall, E. O. New York; Plenum Publishing Corporation (1970). 302p. $16.00.

This book is divided into 8 chapters. The first chapter reviews the general theories of yield point phenomena using sufficient examples to illustrate the theories. The remaining chapters deal with various alloys or groups of alloys exhibiting yield point phenomena. The final chapter is very brief and considers the areas where further research might be fruitful. (B.L.M.)

49450 MICROSTRAIN AND DISLOCATION RELAXATIONS IN BCC METALS. Seeger, Alfred (Max-Planck-Institut fuer Metallforschung, Stuttgart); Sestak, Bohdan. Scr. Met.; 5: No. 8, 681-8(Aug 1971).

A discussion is presented of ⟨111⟩ screw dislocations and kink relaxation in bcc metals. Results of microstrain and internal friction experiments are tabulated and discussed, and an interpretation of the micro stress–strain curve is offered. Impurity effects and dislocation relaxation associated with nonscrew dislocations are discussed. (D.L.C.)

49451 SUBSTITUTIONAL–INTERSTITIAL SOLUTE INTERACTIONS IN Ta–Re–N SOLID SOLUTIONS. Sagues, A. A.; Gibala, R. (Case Western Reserve Univ., Cleveland). Scr. Met.; 5: No. 8, 689-93(Aug 1971).

The effect of Re additions on the Snoek anelasticity of N in Ta was examined. Internal friction measurements were made on specimens of high-purity Ta and Ta–1.3, 2.1, and 3.8 at. % Re before and after ~600 at. ppM N_2 additions. The results show that Re broadens the nitrogen Snoek peak. The internal friction spectrum can be synthesized into component relaxation peaks. (D.L.C.)

49452 METALLOGRAPHIC INVESTIGATION ON THE CLADDING FAILURE IN THE PRESSURE VESSEL OF A BWR. Kondo, Tatsuo; Nakajima, Hajime; Nagasaki, Ryukichi (Japan Atomic Energy Research Inst., Tokai). Nucl. Eng. Des.; 16: No. 3, 205-22(1971).

Samples were removed for metallographic analyses from one of the cracked portions of the multi-layer stainless-steel weld overlay in the JPDR pressure vessel. Metallographic structure and microchemical analysis results were consistent with each other in suggesting that the failure was caused by the significant depletion in the chromium content in the weld metal. The lack in the compositional balance was found to have originated at the overlaying of the first layer on the dissimilar base metal. Morphological features of the cracks indicated the operation of stress corrosion cracking during the process of crack propagation. The chemical composition of the weld metal, thermal history, tensile stress, and environment were judged to have favored the occurrence of cracking. Some of the cracks were found to have reached the base metal across the weld boundaries and further penetrated into the vessel wall in the form of localized corrosion. The attack was of pitting-type corrosion and it was considered to have been accelerated by the concentration-cell action due to the formation of a concentration gradient of dissolved oxygen in water within the narrow cracks. In consideration of the future security of the vessel, containing the defects in the corrosion-resistant liner, further necessary studies were discussed. The probable influence of the high-temperature aqueous environment on the fatigue character of the reactor vessel was pointed out. (auth)

Structure and Phase Studies

49453 (AD–717353) INITIAL STAGES OF THE OMEGA PHASE TRANSFORMATION IN Ti–V ALLOYS. McCabe, Kerry K.; Sass, Stephen L. (Cornell Univ., Ithaca, N. Y. Dept. of Materials Science and Engineering). Jan 1971. Contract N00014-67-A-0077-0012. 24p. (MSC–1413). NTIS.

The as-quenched omega phase and its transition to the aged form of the omega phase was examined using selected area diffraction and dark field electron microscopy. (auth) (USGRDR)

49454 (UJV–2526-M) COURSE OF PHASE TRANSFORMATION AND GRAIN REFINEMENT IN LOW PERCENTAGE ALLOYS OF URANIUM WITH IRON, ALUMINUM, AND SILICON. Kaderabek, E.; Haubelt, I.; Kraus, V. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Mar 1971. 43p. (In Czech). Dep. NTIS (U. S. Sales Only).

The effects of cooling rate on transformation characteristics and grain refinement in dilute binary and polycomponent alloys of uranium with iron, aluminum, and silicon were investigated. Transformation diagrams were determined for continuous cooling in the cooling rate range from 10 to 300°C/sec. The alpha-beta transformations of the alloys are dependent on cooling rate and proceed by mechanisms such as diffusion, bainitic transformation, and martensitic transformation. The highest grain refinement has occurred in the region of bainitic transformation and during martensitic transformation by water quenching. It is shown that the effect of alloying additions (Fe, Al, Si) on transformation kinetics and on grain refinement is not equivalent and fully additive. Among the binary alloys, the greatest transformation hysteresis was observed in U–Si alloys, whereas the highest grain refinement was in U–Fe alloys. Even higher refinement of grain was achieved in U–Fe–Al and U–Fe–Al–Si alloys, however their transformation kinetics has been near to that of binary U–Al alloys. The results have shown that fluctuation of the content of alloying additions in certain intervals should not substantially influence the structure of U–Fe–Al and U–Fe–Al–Si alloys after thermal treatment. (auth)

49455 PRESSURE DEPENDENCE OF POSITRON ANNIHILATION RATES IN THE ALKALI METALS. MacKenzie, I. K.; LeBlanc, R.; McKee, B. T. A. (Dalhousie Univ., Halifax, Nova Scotia). Phys. Rev. Lett.; 27: No. 9, 580-2(30 Aug 1971).

The annihilation rate of positrons in the alkali metals was measured at room temperature for pressures up to 55 kbar. The observed departure from simple predictions of the free-electron gas model are explainable on the basis of changes in the fraction of core annihilations. This interpretation is not, however, consistent with the changes in the Doppler-broadened line shape. (auth)

49456 SHORT RANGE ORDER AND MICRO-DOMAINS IN THE Ni_4Mo SYSTEM. Okamoto, P. R.; Thomas, G. (Univ. of California, Berkeley). Acta Met.; 19: No. 8, 825-41(Aug 1971).

Electron diffraction and field ion microscopy were used to investigate the nature of short range order in as-quenched Ni_4Mo. The results indicate that the as-quenched state consists of an assembly of micro-domains possessing the six orientational variants of the Ni_4Mo superstructure. The $1\frac{1}{2}0$ diffuse peaks were attributed to the occurrence of non-conservative anti-phase boundaries within the micro-domains. A similar argument is used to account for the occurrence of $1\frac{1}{2}0$ peaks in the disordered α-phase at other compositions in the Ni–Mo system. (auth)

49457 DEVELOPMENT OF LONG-RANGE ORDER AND THE RESULTING STRENGTHENING EFFECTS IN Ni_4Mo. Ling, Fu-wen; Starke, E. A. Jr. (Georgia Inst. of Tech., Atlanta). Contract AT(40-1)-3908. Acta Met.; 19: No. 8, 759-68(Aug 1971).

A single crystal of Ni_4Mo was studied by x-ray line broadening techniques using Warren's Fourier analysis employing computer methods. The long-range-order parameter, domain size and microstrains were measured after isothermal aging at 700°C for various times. The ordering occurs homogeneously inside the domains up to a long-range-order parameter of S ~ 0.7. After

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S ~ 0.8, further increase in the degree of order of the crystal is primarily by the elimination of domain boundaries due to domain growth. The rate of the domain growth is analogous to that of grain growth. The x-ray measured r.m.s. strain correlates directly with those calculated from the yield strength measurements. The high strength at the late stage of the ordering is mainly due to the high density of dislocations which are generated as a result of coherent interface strains. (auth)

49458 AUTO-ION-MICROSCOPE INVESTIGATION OF THE INTERGRANULAR LAYER IN TUNGSTEN. Garber, R. I.; Afanas'ev, V. I.; Mikhailov, A. F.; Levandovskii, B. I. (Kharkov State Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 2, 122-3(1971). (In Russian).

During the vaporization of tungsten by an electric field in an autoionic microscope, a transverse, intergranular layer was observed. It is suggested that enhanced stability is associated with the presence in this layer of a compound or mixture that possesses a high heat of vaporization, and that in the tungsten sample investigated, the segregated material could be a carbide or a silicon tungstate. (K.S.W.)

49459 STUDY OF THE $NbAl_3$–Al PHASE DIAGRAM. Wicker, Alain; Allibert, Colette; Driole, Jean (Ecole Nationale Superieure d'Electrochimie et d'Electrometallurgie, Grenoble, France). Compt. Rend., Ser. C; 272: No. 20, 1711-13(17 May 1971). (In French).

The liquidus line of the binary NbAl diagram in the region of $NbAl_3$–Al is presented. The diagram was obtained by electromagnetic separation of the phases present. (auth) (France)

49460 PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON METASTABLE METALLIC ALLOYS, BRELA, YUGOSLAVIA, SEPTEMBER 28–30, 1970. Fizika (Zagreb); 2: Suppl. 2, 1.1-48,2(1970). (CONF-700952).

A total of 46 papers were presented at the conference. A separate abstract was prepared for each of 11 papers. The remaining 35 papers were not within the scope of NSA. (G.M.C.)

For abstracts of individual papers see: 49418, 49419, 49461–49466, 49492, 49584, and 49833.

49461 METASTABLE Gd–Ag ALLOY THIN FILMS. Bates, P. A.; Popplewell, J.; Charles, S. W. (University Coll. of North Wales, Bangor). Fizika (Zagreb); 2: Suppl. 2, 11.1-5(1970).

From International conference on metastable metallic alloys; Brela, Yugoslavia (28 Sep 1970). See CONF-700952.

Properties of Gd–Ag alloys prepared by the vapor quench method were studied. In both low temperature and room temperature deposited samples the change in Curie temperature with decreasing Gd content suggests that the Gd atoms are dispersed by the silver, i.e., the fall in Curie temperature confirms the formation of alloy samples. The behavior of low temperature and room temperature deposited samples differ in that the fall in Curie temperature is more pronounced in the former and below 90 at. % Gd the Curie temperature of the low temperature deposited samples increases while that of the room temperature deposited samples remains constant. It would appear that for room temperature deposited samples the Gd environment does not change appreciably below 90 at. % Gd and that this could result from a tendency for the Gd atoms to cluster. For the low temperature deposited samples there are a number of observations which indicate the possibility of a different structure below 90 at. % Gd. These observations are: the change in Curie temperature; and the change in character of the resonance line width and g factor with composition. When these observations are coupled with the x-ray diffraction data the possibility of a structure change becomes feasible. Microprobe analysis and x-ray diffraction studies show that all alloys can be considered metastable below room temperature but around 200°C there is evidence of the appearance of a two phase structure. (auth)

49462 MARTENSITIC TRANSFORMATION IN A SPLAT COOLED METASTABLE Au–47.5 AT. PERCENT Cd ALLOY. Mukherjee, K.; Ferraglio, Paul (Polytechnic Inst. of Brooklyn). Fizika (Zagreb); 2: Suppl. 2, 27.1-7(1970).

From International conference on metastable metallic alloys; Brela, Yugoslavia (28 Sep 1970). See CONF-700952.

The effects of liquid quenching on the martensitic transformation of an Au–47.5 at. % Cd alloy were studied. In pure metals, high densities of vacancies can be quenched-in by liquid quenching. Also, liquid quenching could possibly produce some change in the long range ordering parameter of the β-phase. Therefore, it was of interest to study the role of such structural defects on the relative stabilities of the parent and the martensitic phases in a splat-cooled alloy. The ordering reaction could not be suppressed by splat quenching, indicating that the relaxation time for ordering was shorter than the quenching time. It might also imply a high degree of short-range order in the liquid phase. The observed increase in superlattice intensity could tentatively be explained by invoking a preferential sublattice vacancy. The retention of the metastable β-phase at room temperature is most likely caused by the excess lattice defects. In β-brass radiation damage is known to suppress the martensitic reaction. Periodic growth faults as well as extremely fine twins could produce the observed heavy $\langle 112 \rangle$ streaking. Since the final martensitic structure is twin related, it is interesting to consider the splitting of twinning dislocations into a/3 [112] sessile components giving rise to the stacking faults on $\{112\}$ planes. Further detailed studies are presently carried out to analyze the crystallography of this transformation. (auth)

49463 PRECIPITATION IN THE ZIRCONIUM–1.5 WT. PERCENT TIN BASE ALLOY. Nesic, O. M.; Stefanovic, V. M.; Spasic, Z. Lj. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Fizika (Zagreb); 2: Suppl. 2, 34.1-8(1970).

From International conference on metastable metallic alloys; Brela, Yugoslavia (28 Sep 1970). See CONF-700952.

In fully beta-annealed Zr–1.5 wt % Sn, at room temperature, two types of precipitates exist: coarse particles distributed at alpha-plate boundaries, and fine homogeneously distributed rod-like precipitates with their long axes parallel to $(11\bar{2}0)_\alpha$ and $(10\bar{1}0)_\alpha$ directions. Crystallographic parameters for rod-like precipitates, directions and habit planes $\{10\bar{1}0\}_\alpha$ $\{10\bar{1}1\}_\alpha$ and $\{11\bar{2}0\}_\alpha$ are the same as for zirconium hydride precipitates. High impurity content suppresses pure Zr_4Sn phase precipitation. From the observations it is expected that, due to their fine precipitates homogeneously discributed throughout the matrix and many coarse precipitates in alpha-plates boundaries, fully annealed Zr–1.5 wt % Sn alloys are susceptible to brittle fracture. (auth)

49464 PRECIPITATION OF SECONDARY PHASE PARTICLE FROM SUPERSATURATED SOLID SOLUTION IN A DILUTE URANIUM ALLOY. Jovanovic, M. (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia). Fizika (Zagreb); 2: Suppl. 2, 35.1-6(1970).

From International conference on metastable metallic alloys; Brela, Yugoslavia (28 Sep 1970). See CONF-700952.

The kinetics of precipitation of secondary phase particles in a dilute uranium alloy (containing 1300 ppM Mo, 170 ppM Si, 500 ppM Fe, 500 ppM Al, and 1000 ppM C) was investigated by thin foil electron microscopy. Precipitation on subgrain boundaries was unequivocally observed by electron microscopy studies. These observations together with determined n values led to the conclusion that heterogeneous nucleation occurred. The calculated activation energy for nucleation and growth was 1.84 eV and the activation energy for the coarsening of particles was 4.4 eV. (G.M.C.)

49465 EXISTENCE OF A NEW INTERMEDIATE NICKEL–BERYLLIUM PHASE. Mazaud, J. C. (Laboratoire de Metallurgie ALCATEL, Veurey-Voroize, France). Fizika (Zagreb); 2: Suppl. 2, 36.1-8(1970).

From International conference on metastable metallic alloys; Brela, Yugoslavia (28 Sep 1970). See CONF-700952.

A new nickel–beryllium phase, called β', which has a body centered tetragonal structure was found in an iron–40% nickel alloy hardened by beryllium, after aging at 700°C. β' parameters and orientation relation in the matrix were determined; β' being a semi-coherent phase. β' shows the crystallographic characteristics of an intermediate phase between the metastable Ni_3Be phase and the stable β NiBe phase. (auth)

49466 KINETICS OF β–α' TRANSFORMATION IN LOW MOLYBDENUM–URANIUM ALLOYS. Mihajlovic, A.; Mance, A.; Djuric, B. (Boris Kidric Inst. of Nuclear Science, Vinca, Yugoslavia). Fizika (Zagreb); 2: Suppl. 2, 43.1-7(1970).

From International conference on metastable metallic alloys; Brela, Yugoslavia (28 Sep 1970). See CONF-700952.

The effect of the overheating degree in the α and β temperature regions on the kinetics of isothermal β–α' transformation was investigated in uranium-0.45 and -0.6% molybdenum alloys. It was found that the β–α' transformation at room temperature depends on time, which indicates that thermal activation affects the kinetics of the process. Kinetics of transformation was analyzed using the modified Avrami equation $x = 1 - \exp(-k\Sigma^n)$. It was found that a concurrence exists between the calculated value of the parameter $n = 2 + 3$ and the experimentally established mode of growth of the martensitic phase. There are indications that the kinetics of β–α' transformation changes at the transition from the upper to the lower β solid solution region. (auth)

49467 DISLOCATION DYNAMICS APPROACH TO PREDICTION OF CLEAVAGE PLANES IN B.C.C. METALS. Ayres, R.; Stein, D. F. (Univ. of Minnesota, Minneapolis). Acta Met.; 19: No. 8, 789-94(Aug 1971).

A new model is proposed to explain (001) cleavage for bcc metals. The model is based on the concept of minimum stress relief. Hypothetical cleavage planes and directions were evaluated to test the model. The model predicts that bcc metals will cleave on the (001) plane because of a minimum of plastic deformation despite a lower apparent surface energy for (110) planes. (auth)

49468 NUCLEATION OF VOIDS IN IRRADIATED METALS. Russell, K. C. (Massachusetts Inst. of Tech., Cambridge). Acta Met.; 19: No. 8, 753-8(Aug 1971).

Conventional nucleation theory cannot properly by applied to the process of co-precipitation of vacancies and interstitials into voids. A proper formalism is developed herein and utilized to derive an expression for the void nucleation rate under these conditions. Although such a system is of a higher degree of irreversibility than those considered by Volmer and by Becker, the resulting rate equations are superficially similar. In the present case, however, the activation barrier is a function of the defect mobilities, hence is not the customary free energy of activation. (auth)

49469 LATTICE PARAMETERS, EXPANSION COEFFICIENTS, DENSITIES OF In AND In–Cd ALLOYS. Straumanis, Martin E.; Rao, Paluri B.; James, William J. (Univ. of Missouri, Rolla). Z. Metallk.; 62: No. 6, 493-8(Jun 1971).

The lattice parameters of 99.999% pure In were redetermined using for calculations the back reflection lines at Bragg angles of 85.4° (442) and of 81.4° (351). Under such conditions a slightly larger c-constant was obtained than reported by other authors. The new values led to a calculated density which agreed very well with the experimentally determined one. Therefore, In appears to have a perfect structure within experimental limits of observation. The thermal expansion coefficient along the c-axis showed a slight break at about 20°C. The c/a value decreased linearly with increasing temperature. Upon addition of Cd to In, a tetragonal solid solution is formed. At Cd amounts exceeding 2%, a cubic solid solution starts to appear by peritectic reaction, according to Heumann and Predel. The two phase region extends at 20°C to about 5.9 wt % Cd. Upon further increase of the Cd concentration, the cubic solid solution continues to exist, but its phase boundary at 20°C is not exactly known. It may extend up to 12 wt % Cd. The solid solutions formed have a perfect substitutional structure and point defects may be present only within the error limits of the experimental determinations. The phase changes tetragonal-cubic occur without change in volume. (auth)

49470 PHASE TRANSFORMATIONS IN SUPERCONDUCTING ALLOY 35BT. Fedotov, L. N.; Kadykova, G. N. Fiz. Metal. Metalloved.; 30: No. 2, 358-62(Aug 1970). (In Russian).

Changes of the structure and superconducting properties after heating and annealing of cold-deformed specimens of alloy 35BT were studied; the alloy contains 30 wt % niobium, titanium, and small additions of zirconium. On annealing cold-deformed specimens below 350°C, decomposition of the metastable β solid solution occurs, with formation of ω phases. After cold deformation and annealing at 450°C for 4 hr, α-phase precipitation bands were observed of width ~360 Å; this state corresponds to a critical current density of 10^5 A/cm^2. In the temperature range 450 to 850°C, an $\alpha \rightarrow \beta$ phase transformation occurs in the alloy. (tr-auth)

49471 INFLUENCE OF HIGH PRESSURE ON PHASE DIAGRAM AND SUPERCONDUCTING PROPERTIES OF Bi–Pb ALLOYS. Ponyatovskii, E. G.; Rabin'kin, A. G. (Inst. of Physics of Solid Substance, Moscow. Inst. of Chemical Physics, Moscow). Fiz. Metal. Metalloved.; 30: No. 3, 606-13(Sep 1970). (In Russian).

The phase composition and superconducting properties of Pb–70 to 95 at. % Bi alloys under the action of high uniform pressures were studied. At 5.5 to 6 kbar, 140°C, and 64 to 66 at. % Bi, a new stable phase emerges, the phase-diagram position of which depends on the value of the pressure p; this phase can be tempered and retained near p = 0. Measurement of the superconducting properties of the alloy in the tempered state showed two superconducting phases, one of which shows H_{c2} of 33 to 34 kOe and T_c ~ 8 to 8.5°K and the other H_{c2} ~ 3 to 6 kOe and T_c ~ 5 to 6°K. Comparison of the structures and properties of the alloys obtained in different metastable states was made. (tr-auth)

49472 EFFECTS OF SHORT-RANGE ORDER AND LONG-RANGE ORDER ON THE EQUILIBRIUM CONFIGURATION OF SUPERDISLOCATIONS IN Fe–Co–2 AT. PERCENT V: CONSEQUENCES ON FLOW STRESS. Moine, P.; Eymery, J. P.; Grosbras, P. (Faculte des Sciences, Poitiers, France). Phys. Status Solidi (b); 46: No. 1, 177-85(1 Jul 1971).

The variations in flow stress of Fe–Co–2 at. % V as a function of test or quench temperature exhibit a maximum near the critical temperature for ordering, T_c. Transmission microscope study of thin foils reveals the existence of paired dislocations not only at temperatures below T_c but also at temperatures above T_c where only short-range order exists; calculations of their equilibrium spacing using the quasi-chemical theory are in agreement with experimental results. The peak in flow stress may be explained assuming that for high values of S (S is the long-range order parameter) the dislocation sources are constituted by paired dislocations which keep parallel configurations when operating, and that for low values of S (or S = 0) sources are constituted by single dislocations or by paired dislocations with only one of them operating. (auth)

49473 SUBSTRUCTURE AND MICROTOPOGRAPHY OF TUNGSTEN FIBERS TESTED TO FAILURE. Garber, R. I.; Dranova, Zh. I.; Mikhailovskii, I. M.; Fridman, V. Ya. (Physical-Technical Inst., Kharkow). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 2, 339-41(Aug 1971).

Translated from Fiz. Tverd. Tela; 13: No. 2, 416-20(Feb 1971).

Field-ion microscopy has been used to study tungsten wires 0.07 to 0.17 μ in diameter tested to failure in tension in a microdrawbench. There is an anomalously high density of point defects in the failure region, which exceeds by a factor of 10^2 to 10^3 the concentration in the original material. There is also a high density of slit dislocations in the {110} and {321} planes. Dislocations are generated homogeneously in specimens that fail at stresses corresponding to the strength of ideal crystals, as is evident from the structure defects. (auth)

49474 EXAMINATION OF SUBSTOICHIOMETRIC WO_{3-x} CRYSTALS BY ELECTRON MICROSCOPY. Allpress, J. G. (Univ. of Melbourne); Tilley, R. J. D.; Sienko, M. J. J. Solid State Chem.; 3: No. 3, 440-51(Aug 1971).

The defect structure of high-purity crystals of tungsten oxides with compositions between $WO_{3.00}$ and $WO_{2.99}$ was investigated by transmission electron microscopy. The oxygen deficiency appears to be accommodated by Wadsley defects, disordered crystallographic shear planes, parallel to $\{120\}_R$ (R = ReO_3-type parent lattice). The planes tend to collect into bands which cause some regions of the crystal to have compositions far removed from the bulk. An observed maximum in carrier mobility is attributed to the destruction of conduction band states in the defect-rich regions. A modified form of the dislocation model for shear plane formation is proposed. (auth)

49475 DETERMINATION OF PHASE BOUNDARIES IN SYSTEMS OF Ti WITH V, Nb, AND Mo BY THE METHOD OF DIFFUSION LAYERS. Ronami, G. N.; Kuznetsova, S. M.; Fedotov, S. G.; Konstantinov, K. M. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 11: No. 2, 186-9(Mar-Apr 1970). (In Russian).

The diffusion-layer method, along with x-ray microanalysis, was used to determine $\alpha/(\alpha + \beta)$ and $\beta/(\alpha + \beta)$ phase boundaries in Ti–Nb, Ti–Mo, and Ti–V systems. (tr-auth)

49476 MECHANISMS OF GRAIN REFINEMENT IN DILUTE ALUMINUM ALLOYS. Delamore, G. W.; Smith, R. W. (Queen's Univ., Kingston, Ont.). Met. Trans.; 2: No. 6, 1733-8(Jun 1971).

The contribution of the peritectic reaction in producing grain refinement in aluminum alloys has been studied in three binary aluminum systems. It appears that titanium has a unique effect compared with zirconium or chromium; there is evidence of a refinement mechanism associated with the peritectic reaction in Al–Ti alloys which was not observed in the other two systems. Additions of boron to Al–Ti and Al–Zr alloys emphasizes the difference in effect of these two transition elements as grain refiners. The significance of the results is discussed with reference to conflicts apparent in earlier experimental data. (auth)

49477 CONTROL OF γ PARTICLE SIZE AND VOLUME FRACTION IN THE HIGH TEMPERATURE SUPERALLOY UDIMET 700. Van der Molen, E. H.; Oblak, J. M.; Kriege, O. H. (Pratt and Whitney Aircraft, Middletown, Conn.). Met. Trans.; 2: No. 6, 1627-33(Jun 1971).

Experiments were conducted to determine the chemical composition, volume fraction, and particle size of the γ' precipitate in Udimet 700 as a function of temperature and time. Growth of the γ' particles was found to follow $t^{\frac{1}{3}}$ diffusion controlled coarsening kinetics. The composition of γ' varied only slightly with temperature and was independent of time. Using this information, a method was developed to estimate the volume fraction and average particle size of the γ' precipitate for any given heat treatment. It

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is suggested that this approach could be applied to other γ' strengthened superalloys. (auth)

49478 INFLUENCE OF PRIOR COLD WORK ON THE DISCONTINUOUS PRECIPITATION IN COPPER–2 WT. PERCENT Be. Kreye, Heinrich (Bell Telephone Labs., Inc., Murray Hill, N. J.). Z. Metallk.; 62: No. 7, 556-62(Jul 1971).

The discontinuous precipitation of the equilibrium γ phase in copper–2 wt% Be is in the range 20 to 50% RA increased due to an increase in the density of the reaction fronts. Additional reaction fronts are formed at deformation bands. In the range 50 to 90% RA the competition with the continuous precipitation of γ in front of the reaction front leads to a decrease in the rate of the discontinuous reaction. After cold work of more than 90% RA no discontinuous precipitation is found. At higher annealing temperatures (470°C) the rate of discontinuous reaction decreases in the range 0 to 20% RA as the mobility of the reaction front is decreased by the presence of larger metastable γ particles. (auth)

49479 NATURE OF THE PHYSICO-CHEMICAL INTERACTION OF HAFNIUM WITH EUROPIUM. Savitskii, E. M.; Arabei, B. G.; Bakarinova, V. I.; (and others). At. Energ. (USSR); 30: No. 4, 390-1(Apr 1971). (In Russian).

Although hafnium and europium have high chemical activity, the refractoriness of the first element and the high vapor pressure of the second make it difficult to prepare alloys with them. Tests were carried out to melt them together in a sealed molybdenum ampoule under an argon atmosphere, keeping the system at various temperatures between 800 and 1600°C for 100 hours. Spectrochemical, x-ray diffraction, microscopic, and phase-analysis techniques were used to determine the mutual solubility of the two elements in each other. It was found that the solubility was very low: the maximum solubility of hafnium in europium amounted to about 1.7 wt % at 850°C and ~0.7 wt % at higher temperatures while the solubility of europium in hafnium at all investigated temperatures was found to be about 0.03 wt %. No new phases were observed in the hafnium-based system by x-ray diffraction; the lattice constants of the alloys were the same as those of the original hafnium. Increase of temperature produce only grain growth. The solubility of hafnium in europium was not studied because of the potential interaction of the components with the material of the ampoule. Microscopic and spectral analyses indicated that at temperatures >1800°C, an interaction takes place in the Eu–Hf–Mo ternary system. The derived phase diagram for the europium–hafnium system thus exhibited very slight mutual solubility and the absence of intermediate phases. (TTT)

Radiation Effects

Refer also to abstracts 48703, 48758, 49576, 49579, 49985, 51031, 51082, 51083, 51098, 51173, and 51175.

49480 (AD–717618) SM-1A REACTOR PRESSURE VESSEL SURVEILLANCE: IRRADIATION OF FOLLOW-ON CAPSULES IN THE SM-1 REACTOR. Serpan, Charles Z. Jr. (Naval Research Lab., Washington, D. C.). 14 Dec 1970. Contract AT-(49-5)-2110. 15p. (NRL–7211). NTIS.

Three capsules containing Charpy V-notch specimens of a duplicate ring-forging of SM-1A reactor pressure vessel steel were prepared for placement into the SM-1A reactor as part of the continuing vessel surveillance program of that reactor. These capsules plus two more control capsules were irradiated in the SM-1 reactor at 440°F to match the SM-1A reactor pressure vessel transition temperature and fluence conditions prior to the SM-1A annealing. The capsules were then furnace annealed under the SM-1A reactor annealing conditions and were reirradiated in the SM-1 to the fluence and transition-temperature conditions of the SM-1A at the end of Core 3. Control points were established after each step. Significant differences in flux levels at a point in the SM-1 reactor were noted between an earlier flux-monitor irradiation and the subsequent surveillance-capsule irradiations. These differences were found to be directly related to the two different fuel cores in place at those times. Higher fluxes were generated at the core edge during the flux monitor irradiation since the core was old and the center was considerably burned out. Lower fluxes were measured at the same core-edge location during the surveillance-capsule irradiations since a new, smaller diameter core peaked in flux toward the center. The information developed and documented will be required for evaluation of the surveillance capsules after they are removed from irradiation in the SM-1A reactor. (auth) (USGRDR)

49481 (AD–721068) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Quarterly Progress Report, November 1, 1970–January 31, 1971. Steele, L. E.; Serpan, C. Z. Jr.; Watson, H. E.; Hawthorne, J. R.; Smidt, F. A. Jr. (Naval Research Lab., Washington, D. C.). 15 Feb 1971. Contract AT-(49-5)-2110. 34p. (NRL–MR–2214). NTIS.

The report includes: (1) an analysis of the comparative results of various reactor physics codes for predicting the neutron spectrum in a simulated pressure vessel, (2) the fracture resistance of irradiated A533-B steel plate and weld metal as defined by shelf level in dynamic notched impact tests, and (3) results suggesting possible mechanisms of loop growth during damage recovery in vanadium. (auth) (USGRDR)

49482 (ANL-ms–1336) EXPERIMENTS TO DETERMINE THE NUMBER OF "FREE VACANCIES" IN A FISSION NEUTRON DISPLACEMENT CASCADE. Blewitt, T. H.; Klank, A. C.; Scott, T.; Weber, W. (Argonne National Lab., Ill.). Jun 1971. 20p. (CONF-710601–9). Dep. NTIS.

From International conference on radiation-induced voids in metals; Albany, N. Y. (9 Jun 1971).

An experiment designed to determine the number of free vacancies in a cascade is described. Results show that the number of vacancies in Cu–Au alloys escaping from a fast neutron is very small. Less than 10% of the vacancies created migrate long distances. At low temperatures, i.e., below stage V recovery or $T_m/2$, there are radiation-induced sites associated with high energy cascades that trap or annihilate vacancies. It is suggested that these sites are associated with the defect agglomeration, which causes hardness and are spontaneously formed in the cascade to recover with an activation energy, in many cases, close to that of the self diffusion activation energy. (auth)

49483 (BNWL-SA–3920) VOID FORMATION IN NEUTRON IRRADIATED MOLYBDENUM AND RHENIUM. Brimhall, J. L.; Kulcinski, G. L.; Kissinger, H. E. (Battelle Pacific Northwest Labs., Richland, Wash.). [1971]. 12p. (CONF-710905–2). Dep. NTIS.

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971).

The effects of temperature on neutron-induced void formation in TZM, Mo, and Re at 600 to 1450°C were investigated. Using additional data from other studies, the temperature dependence of volume change at 50 to 1450°C was determined. Results of the investigation showed that the void size increases and the density decreases with increase in irradiation temperature for both Mo and Re. (J.R.D.)

49484 (BNWL-SA–3922) HIGH TEMPERATURE HEAVY ION BOMBARDMENT OF Mo, Nb, AND TZM. Kulcinski, G. L.; Brimhall, J. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1971]. 10p. (CONF-710905–1). Dep. NTIS.

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971).

Results of studies of heavy ion bombardment of Nb, Mo, and TZM show that voids were formed in all three metals after 800, 900, and 1000°C irradiation. No voids were found in Nb and Mo that were irradiated at 650 and 700°C; only dislocation loops and segments were found. There was also some evidence for the formation of precipitation along with voids in the TZM alloys during 800 and 900°C bombardments. The average void size in the metal was shown to increase with increasing irradiation temperature in all the metals and the number density was reduced. (D.H.M.)

49485 (CONF-710520–4) INFLUENCE OF NEUTRON IRRADIATION ON THE CORROSION OF ZIRCALOY-2 AT 240°C. Lunde, Liv; Videm, Ketil (Institutt for Atomenergi, Kjeller (Norway)). [1971]. 7p. Dep. NTIS (U. S. Sales Only).

From sixth Scandinavian corrosion congress; Gothenburg, Sweden (24 May 1971).

Zircaloy-2 specimens have been exposed at 240°C at various locations in the primary circuit of the Halden Boiling Water Reactor. Data have also been collected from Zircaloy-2-clad fuel elements. The corrosion rate with absence of irradiation agreed well with published data. Neutron irradiation caused a drastic acceleration of the attack, leading to a corrosion rate about 0.15 mg/dm^2 day. A change in the post-transition corrosion mechanism under irradiation is suggested to occur between 240 to 290°C. Variations in the flux level, 2×10^9 to 3×10^{12} n/cm^2/sec (>1 MeV), had little influence on the corrosion rate. The total pick-up was about 25% of the hydrogen and deuterium atoms liberated. The metal absorbed mainly hydrogen, despite a content in the heavy water of no more than 0.7% light water. (auth) (Sweden)

49486 (CONF-710601–10) VOID FORMATION IN PROTON AND NICKEL IRRADIATED TYPE 304 STAINLESS STEEL. Taylor, A.; McDonald, S. G. (Argonne National Lab., Ill.). Jun 1971. 23p. Dep. NTIS.

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From International conference on radiation-induced voids in metals; Albany, N. Y. (9 Jun 1971).

The swelling of several samples of Type 304 stainless steel bombarded with 1.25-MeV protons or 3.5 to 4.0-MeV Ni^+ ions has been studied using quantitative stereo electron microscopy. The swelling of proton bombarded samples is significantly greater than the Ni^+ bombarded samples and there was no indication of any saturation with dosage. Void formation occurred by sequential nucleation and growth. (auth)

49487 (ORNL-TM-3300, pp 97-133) MECHANICAL PROPERTIES OF ALLOYS IN REACTOR ENVIRONMENTS AND DEVELOPMENT OF LMFBR CLADDING AND STRUCTURAL MATERIALS. Weir, J. R. Jr.; McCoy, H. E. Jr. (Oak Ridge National Lab., Tenn.).

Irradiation experiments are in progress on Types 304, 316, and 318 stainless steel, Ti-modified Types 304 and 316 stainless steel, Sandvik 12R72HV, 19-9-DL, and Incoloy 800. These materials have been worked and annealed to obtain various microstructures and are being irradiated at 350 to 800°C to fast fluences of at least 3.5×10^{22} neutrons/cm^2. Samples of these materials were removed and are in various states of examination. The irradiation of annealed Type 304 stainless steel to fast fluences of 1.5 to 3.5×10^{22} neutrons/cm^2 at 535 and 590°C causes modest changes in the rupture life and minimum creep rate at 550 and 600°C. Irradiation at 800°C reduces the rupture life and increases the minimum creep rate. The change in the fracture strain was the most significant; values as low as 0.5% were observed. Tensile and creep-rupture tests of the irradiated Ti-modified alloy showed that this material had higher fracture strains than standard Type 304 stainless steel. The Mo and Ti concentrations in several alloys of Type 316 stainless steel were varied over small ranges. The swelling measured after exposure in HFIR to a fast fluence of 1.5 to 2.9×10^{22} neutrons/cm^2 at 575 to 600°C was increased slightly with increasing Mo and decreased drastically with increasing Ti. The recrystallization and precipitation that occur in the standard and Ti-modified steel after solution annealing and cold working were characterized as a function of annealing temperature. Further studies were made of the precipitates that formed in several heats. The phases present under certain conditions were $M_{23}C_6$, TiN, TiC, $Ti_2(S,C)$, χ, Laves, and σ. Studies on aged Incoloy 800 showed that aging at 550°C was reduced markedly by following the solution anneal of 0.5 hr at 1150°C with a 100 hr anneal at 800°C. These heats contained 0.03 to 0.1% C and 0.1 to 0.27% Ti; the aging response decreased with decreasing C content and was unaffected by Ti concentration. Samples of Nb and Nb–1% Zr were irradiated at 790 ± 25°C to a fluence of 2.5×10^{22} neutrons/cm^2. The voids were small and uniformly distributed in the Nb sample, but were generally larger and very inhomogeneously distributed in the alloy. However, the bulk swelling of the two materials under those conditions was not significantly different. A capsule is being designed for irradiation of W and W-base alloys in the EBR-II at 900 to 1800°C. (auth)

49488 (ORNL-TM-3300, pp 276-94) IRRADIATION DAMAGE TO ALUMINUM AND ALUMINUM ALLOYS. Weir, J. R. Jr.; King, R. T. (Oak Ridge National Lab., Tenn.).

Density measurements and tensile tests were performed on specimens cut from the 6061 Al target basket, a component irradiated at 60°C in the HFIR. The maximum change in density was –1.06% for a specimen that had received a neutron fluence of 5.4×10^{22} neutrons/cm^2 (>0.8 MeV) and 1.2×10^{23} neutrons/cm^2 (thermal). This Mg_2Si precipitate-hardened alloy swells less than solid-solution alloys or high-purity Al under similar conditions. The effects of neutron fluence, deformation rate, and deformation temperature on mechanical properties were investigated. Strengthening was induced by irradiation, but the tensile strength tended to increase with increasing deformation rate. The ductility of the irradiated alloy was reduced below that of control specimens over the entire range of test temperatures (25 to 500°C), but a set of conditions leading to particularly low ductilities was high neutron fluences [above 3×10^{22} neutrons/cm^2 (>0.8 MeV)] at temperatures near 200°C for slow deformation rates. This information is of particular value in determining the service life of certain Al components for use in-reactor. (auth)

49489 (ORNL-TM-3416, pp 75-108) MECHANICAL PROPERTIES OF ALLOYS IN REACTOR ENVIRONMENTS AND DEVELOPMENT OF LMFBR CLADDING AND STRUCTURAL MATERIALS. (Oak Ridge National Lab., Tenn.).

In fuels and materials development program quarterly progress report for period ending March 31, 1971.

Examination of annealed Type 304 stainless steel irradiated at 590°C to fast fluences of 1.8, 2.3, and 3.5×10^{22} neutrons/cm^2 has shown that the rate of nucleation of voids decreases sharply with increasing fluence, but that void growth continues. At high fluences swelling should become proportional to the fluence raised to the power of 1.5 compared with a power of 5 at low fluences. Type 304 stainless steel was irradiated to a fluence of 2.5×10^{22} neutrons/cm^2 at 450°C in metallurgical conditions such as annealed, cold-worked 10%, and cold-worked 10% and annealed 24 hr at 480°C and 100 hr at 700°C (recovered). The cold-worked specimen swelled less than the annealed one because of a large decrease in void concentration. The recovered specimen swelled more than the annealed one because of an increase in void sizes. Results of tensile tests on standard and Ti-modified Types 316 stainless steel in the irradiated and unirradiated conditions showed the properties to be sensitive to metallurgical condition (annealed and 20% cold-worked), aging, and irradiation. Samples of standard and Ti-modified stainless steel irradiated at 450 to 800°C to a peak fluence of 2.7×10^{22} neutrons/cm^2 have been removed from EBR-II and partially characterized. The Ti-modified steel consistently shows smaller density changes than those of the standard alloy. Samples of recrystallized Ta irradiated in EBR-II at 425, 585, 790, and 1000°C to fluences of 2.5 to 4.4×10^{22} neutrons/cm^2 have been thinned and examined. The sample irradiated at 425°C contained small loops but no voids. The samples irradiated at the other three temperatures contained voids. High-purity aluminum, 50% cold-worked 1100 grade, 50% cold-worked 8001 grade, "0" temper 6061 grade, and T-6 temper 6061 grade were irradiated in HFIR at 140 to 200°C at neutron fluences of 0.4 to 1.6×10^{22} neutrons/cm^2. Voids were found in the high-purity aluminum over much of the temperature range, but voids were not observable in the other alloys. Silicon precipitates arising from the transmutation of aluminum were present in most materials. Creep-rupture tests on 8001 showed that irradiation increased the rupture life, decreased the creep rate, and decreased the fracture strain. (auth)

49490 (RD/B/N-1812) EFFECTS OF HIGH FLUX NEUTRON IRRADIATION ON THE MICROSTRUCTURE OF METALS. Fisher, S. B.; Williams, K. R. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Dec 1970. 24p. (FRDC/FEWP/P-(70)-559). Dep. NTIS (U. S. Sales Only).

The fast reactor development sequence involves an increase in fast neutron flux. The consequences of such an increase on the microstructure of cladding material are discussed as far as is possible with available data from in-reactor and HVEM studies. (auth)

49491 MEASURING IRRADIATION-INDUCED DEFORMATIONS OF MATERIALS. Schultz, Warner W. (to United States Atomic Energy Commission). U. S. Patent 3,577,199. 4 May 1971. Filed 22 Aug 1969.

Methods and apparatus for measuring irradiation-induced change in length of a test sample are described. Neutron irradiation produces a differential change between the lengths of a test sample and a comparison standard. Mechanical pivot means are provided for magnifying the differential change in length. Means including a source of fissionable material and a track detector surface are provided for recording the magnified differential change in length. (Official Gazette)

49492 SOME EVIDENCE ON THE NON-EQUILIBRIUM CARBON CONCENTRATION PRODUCED BY FAST-NEUTRON IRRADIATION OF IRON–CARBON ALLOYS. Milasin, N. Lj. (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia). Fizika (Zagreb); 2: Suppl. 2, 45,1-6(1970).

From International conference on metastable metallic alloys; Brela, Yugoslavia (28 Sep 1970). See CONF-700952.

The carbon behavior in α-iron was studied during irradiation and after post-irradiation annealing. The sample was exposed to an integrated flux of 3.5×10^{19} n/cm^2 (E > 1 MeV). It was found that: the microhardness increased after irradiation; the microhardness peak after post-irradiation annealing was at about 125°C; and the yield stress peak was at about 125°C, the amplitude of the peak depended on the carbon content. From the data and calculations radiation anneal hardening of α-iron was attributed to the strengthening of defects by carbon atoms from a supersaturated solution created during irradiation. (G.M.C.)

49493 SOME ASPECTS OF VESSELS FOR SPECIAL PURPOSES. B. THE NUCLEAR REACTOR PRESSURE VESSEL AND THE PROBLEM OF IRRADIATION EMBRITTLEMENT. Nichols, R. W. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). pp 498-531 of Pressure Vessel Engineering Technology. /Nichols, R. W. (ed.). New York; American Elsevier Publishing Co., Inc. (1971).

The main factors associated with irradiation effects on pressure vessel materials are described and illustrated by use of experimental results. Discussions are included on the nature of irradiation damage, radiation effects on mechanical properties and brittleness, and damage monitoring. (J.R.D.)

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49494 IN-SITU FIELD ION MICROSCOPE STUDY OF STAGE I RECOVERY IN TUNGSTEN IRRADIATED WITH 20 keV W^+. Scanlan, Ronald Merlin. Ithaca, N. Y.; Cornell Univ. (1971). 95p. University Microfilms Order No. 71-17,665.

Thesis.

The mobility of single self-interstitial atoms was studied in a series of in-situ field ion microscope (FIM) experiments. High purity ($\leq 1.5 \cdot 10^{-4}$ at. % impurity level) W specimens were irradiated with 20 keV W^+ ions under ultrahigh vacuum ($\sim 10^{-10}$ torr) conditions at temperatures between 8 and 18°K. The specimens were examined directly at the irradiation temperature employing the pulse field evaporation technique. The initial state of damage at 15°K consisted of depleted zones within 100 Å of the irradiated surface and a distribution of immobile self-interstitial atoms, which were distributed throughout the bulk of the specimen, and which originated at the depleted zones. Direct observation of the FIM specimens during subsequent annealing experiments between 15 and 120°K showed that these self-interstitial atoms underwent long-range migration (i.e., distances of ~200 Å) in Stage I and were mobile at temperatures as low as ~28°K. Warming these same specimens to 298°K (~middle of Stage II) followed by post-anneal pulse field evaporation experiments at 15°K showed that the initial concentration of self-interstitial atoms, which were distributed throughout the volume of the specimens, decreased by at least an order of magnitude as a result of this annealing treatment. Control experiments were performed to show that the imaging electric field did not cause a long-range stress induced migration of these self-interstitial atoms. In addition, an extensive series of control experiments were carried out to show that the phenomena reported were not due to impurity interstitial atoms or surface artifacts. These experiments were analyzed quantitatively, and approximate values of the diffusion coefficient, and the enthalpy change of migration of the self-interstitial atoms were obtained. The effect of the electric field on the diffusivity of a single self-interstitial atom was also considered, and it was shown that the volume change of migration for a self-interstitial atom must have been less than ~0.05 atomic volume. The problems of self-interstitial atom clustering and the formation of self-interstitial impurity clusters were considered and were shown to be possible sources of the broad annealing spectrum. In addition the relationship of the post-anneal field evaporation experiments to the 2-interstitial recovery model was discussed. The results were compared with other Stage I recovery data on irradiated tungsten. The temperature distribution in a field ion microscope (FIM) specimen heated simultaneously by thermal radiation, the imaging gas, and an energetic beam of charged particles were calculated in the steady-state approximation employing a realistic model for the FIM specimen. The variation in cross-sectional area of the specimen with distance along the shank was taken into full account. The value of ΔT_{max} (maximum temperature difference along the length of the specimen) was $\sim 2.5 \cdot 10^{-3}$°K at the best image voltage (4.4 Volt $Å^{-1}$) for tungsten imaged with helium. It was concluded that the act of observing a specimen by field ion microscopy did not appreciably perturb the temperature of the tip. It is shown that a high energy density beam of energetic particles was required to produce a significant value of ΔT_{max}. The possibility of a temperature change caused by the thermoelastic effect was considered and shown not to be of importance. (Diss. Abstr. Int., B)

49495 SWELLING OF CLADDING- AND STRUCTURAL MATERIALS UNDER NEUTRON IRRADIATION. Ehrlich, K. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech.; 16: No. 7, 356-8(Jul 1971). (In German).

One of the most significant problems in the development of fast breeders resides in the behavior of cladding and structural materials exposed to high flux of fast neutrons in sodium-cooled fast reactors. With the experimental irradiations thus far achieved in the fast reactors EBR-II, DFR, and Rapsodie, only one-half of the maximal desired neutron doses were obtained. For extrapolation of the experimental results, the phenomenon of pore formation possesses fundamental significance as discussed in detail. Pore formation is of interest especially with respect to temperature distribution that is studied up to high neutron doses on steels of Type 4988 and 4970. At the end of 1971, sufficient data are expected to facilitate selection of suitable materials, especially with respect to swelling. (tr-auth)

49496 DIFFUSION UNDER RADIATION EFFECT. Schenk, M. (Institutsteil fuer Metallphysik und Reinstmetalle, Dresden). pp 161-82 of Diffusion in Metallischen Werkstoffen. Leipzig; VEB Deutscher Verlag fuer Grundstoffindustrie (1970). (In German).

From seventh metal meeting; Dresden, Germany (1 Apr 1970). See CONF-700436.

Both vacancies and interstitial atoms are produced under radiation. In order to determine which experiments and conclusions are possible with a given type of radiation, the defect producing mechanisms effective under the different types of radiation are summarized. Radiation-accelerated and delayed diffusion is then considered. The alloys Cu_3Au, Ni–Be, Cu–Ni, α-brass, and α-iron are discussed. (J.S.R.)

Ceramics and Cermets

Refer also to abstracts 48735, 49343–49345, and 51030.

Corrosion and Erosion

Refer also to abstracts 48736, 48738, 50266, 51073, and 51141.

49497 ACTIVE TO PASSIVE TRANSITION IN THE OXIDATION OF SiC. Antill, J. E.; Warburton, J. B. (Atomic Energy Research Establishment, Harwell, Eng.). Corros. Sci.; 11: No. 6, 337-42(Jun 1971).

The active to passive transition in the corrosion of SiC was studied at 1000 and 1200°C with O_2, H_2O vapor and CO_2 as oxidants. The pressures of the oxidant at transition were found to agree with a previously published theoretical model although active corrosion rates are at least five orders of magnitude less than those predicted. An adaptation of the model involving the formation of a discontinuous film of SiO_2 on the carbide surface during active corrosion is consistent with the results and previously published work. (auth) (UK)

49498 REACTIVITY OF GRAPHITE SURFACES WITH ATOMS AND MOLECULES OF HYDROGEN, OXYGEN, AND NITROGEN. McCarroll, Bruce; McKee, D. W. (General Electric Research and Development Center, Schenectady, N. Y.). Carbon; 9: No. 3, 301-11(May 1971).

The topological changes resulting from the attack of gaseous hydrogen, oxygen, and nitrogen on the basal plane surfaces of natural graphite crystals were studied optically. Undissociated hydrogen and nitrogen appear unreactive toward heated graphite in the temperature range 300 to 1200°C. The hexagonal etch pits produced by atomic hydrogen on graphite at 700 to 800°C have two sides oriented perpendicular to the $\{11\bar{2}1\}$ twin bands, whereas nitrogen atoms impinging on the crystals at temperatures above 1000°C give rise to hexagonal pits with two sides parallel to the twin bands. These latter pits are similar to those found with molecular oxygen at lower temperatures. By contrast, atomic oxygen causes random unoriented pitting over the whole basal plane surface. These results are discussed in terms of the possible reaction products and estimates of the behavior of the adsorbate species on the graphite surface. (auth) (UK)

49499 CARBON LOSS FROM GRAPHITE CYLINDERS EXPOSED TO STEAM FOR SHORT TIMES. Oezisik, M. Necati. (North Carolina State Univ., Raleigh); de Nordwall, H. J. Nucl. Sci. Eng.; 44: No. 3, 310-19(Jun 1971).

The rate, extent, and spatial variation of carbon loss from a graphite cylinder exposed to steam has been calculated as a function of time. The geometrical arrangement considered was a hollow cylinder with a helium–steam mixture on the inside. At the outer boundary either a zero concentration or a zero steam flux may be maintained. The reaction was assumed to be first order. Changes in the rate of carbon removal with time other than those associated with establishing a steady-state steam concentration gradient were not considered. Calculations using constants derived from current experimental work lead one to conclude that the time needed to establish a concentration gradient is insignificant compared with the times for which the hot core of a high-temperature gas-cooled reactor could be exposed to steam accidentally. This conclusion could change if much tighter graphites or more massive sections, equivalent to thicker cylinders in the analysis, were to be used. (auth)

49500 CORROSION TESTS ON REFRACTORY AND CERAMIC MATERIALS IN METALLIC SODIUM AT 850°C. Budnikov, P. P.; Kharitonov, F. Ya.; Matlis, Ya. V.; Zemlyakova, Z. F. J. Appl. Chem. USSR (Engl. Transl.); 43: No. 12, 2652-5(Dec 1970).

Translated from Zh. Prikl. Khim.; 43: No. 12, 1610-13(Dec 1970).

Experimental corrosion tests for times of 100 to 500 hr at 850°C were run on the following materials: fireclay, magnesite, dolomite, forsterite, spinel, high-alumina, stabilized ZrO_2, fused magnesite, fused MgO. Al_2O_3 spinel, slip-cast spinel, mikrolit (corundum-type), and corundum materials. The greatest resistance to 850°C sodium was shown by materials which approximate single crystals in density and do not contain glass phase (mikrolit), or chemically inert electrically fused materials (magnesite and spinel) of minimal porosity. (D.L.C.)

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49501 CORROSION OF ALUMINUM AND BERYLLIUM OXIDES IN GASEOUS AMMONIA AT TEMPERATURES OF 200 TO 800°C. Budnikov, P. P.; Belyaev, R. A.; Volodin, P. L.; (and others). J. Appl. Chem. USSR (Engl. Transl.); 44: No. 1, 51-5(Jan 1971).

Translated from Zh. Prikl. Khim.; 44: No. 1, 54-9(Jan 1971).

Dense sintered beryllium oxide and aluminum oxide do not undergo corrosion in ammonia or its decomposition products in the 200 to 800° temperature range. This is confirmed both by the constant weight of the specimens and by the results of studies of the specimen surfaces by the metallographic and electron-microscopic methods. Ammonia passed over dense sintered beryllium oxide and aluminum oxide at a rate of 10 m/sec has no corrosive or erosive effects in the 250 to 350° temperature range. (auth)

49502 DISINTEGRATION OF CARBIDES DURING ABRASIVE WEAR. Popov, V. S.; Nagornyi, P. L. (Mechanical Engineering Inst., Zaporozhe, USSR). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 2, 196-200(Feb 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 2, 222-7(Feb 1971).

The energy required to overcome the interatomic bonding forces in carbides is examined. The carbides in wear-resistant alloys may be placed in the following order of decreasing limiting disintegration energy ($kg \cdot mm/mm^3$): NbC, TiC, VC, TaC, WC, B_4C, Nb_2C, Fe_3C, Cr_3C_2, SiC, Mn_3C, Cr_7C_3, and $Cr_{23}C_6$. (auth)

Preparation and Fabrication

Refer also to abstracts 48734, 49393, and 49436.

49503 (AERE-M-2456) EXTRUSION OF CARBIDE POWDERS. Pape, R. P. (Atomic Energy Research Establishment, Harwell (England)). Jun 1971. 16p. Dep. NTIS (U. S. Sales Only).

The extrudability of plasticized carbide powders was investigated as the first stage in the development of a process for the cold co-extrusion of pyrophoric ceramic powders to form composite bodies. Tests were conducted on batches of WC and UC powder, mixed with paraffin wax. It was demonstrated that WC could be extruded and fired to 98% theoretical density. UC could be readily extruded, but difficulty was encountered with removal of the plasticizer. It was concluded that co-extrusion was likely to present considerable technical problems. (auth) (UK)

49504 (LA-4714) CMB-13 RESEARCH ON CARBON AND GRAPHITE. Report No. 16. Summary of Progress, November 1, 1970-January 31, 1971. Smith, Morton C. (Los Alamos Scientific Lab., N. Mex.). Jul 1971. Contract W-7405-eng-36. 40p. Dep. NTIS.

Research is described on carbon and graphite conducted to increase understanding of their properties and behavior as engineering materials, to improve the raw materials and processes used in their manufacture, and to learn how to produce them with consistent, predictable, useful combinations of properties. Results of work are reported on Santa Maria coke; highly oriented polycrystalline graphites; graphite-carbide composites; raw materials; manufacturing variables; porosity effects; and thermal-shock resistance of extruded, resin-bonded graphites. (D.H.M.)

49505 (ORNL-TM-3300, pp 53-96) DEVELOPMENT OF ADVANCED FBR FUELS. Patriarca, P.; Scott, J. L. (Oak Ridge National Lab., Tenn.).

The sintering of $(U_{0.8},Pu_{0.2})N$ compacted powders derived from U-Pu alloy or from mechanical mixtures of Un and PuN is improved by heat treating the compacts while maintaining a N_2 pressure above the value that will lead to decomposition of the mononitride phase. The enhanced sintering effect is more pronounced at lower temperatures, such as 1800, than at 2200°C. Mechanical mixtures of UN and PuN are difficult to sinter to greater than 85% of theoretical density because of the difficulty of obtaining uniform diffusion of one compound into the other. The Dumas method for analysis of N in nitrides shows great promise for use with (U,Pu)N since it allows rapid collection of the N and does not require a dissolution procedure before the analysis. Essentially identical results were obtained for the N content of UN by the Dumas method and by the Kjeldahl method after dissolution in H_3PO_4. Uranium-plutonium alloys were received for use in producing (U,Pu)N fuel for irradiation experiments in the EBR-II, and the nitride powders are being synthesized. Two capsules containing (U,Pu)N clad with Type 316 stainless steel were inserted into the ETR in December. (auth)

49506 (ORNL-TM-3300, pp 188-208) DEVELOPMENT OF FBR NEUTRON-ABSORBER MATERIALS. Adamson, G. M. Jr.; Martin, W. R. (Oak Ridge National Lab., Tenn.).

Boron carbide with a B:C ratio of 4.5 may contain free B, depending upon the fabrication schedule. When free B was present, the rate of He release from the (n,α) reaction during irradiation at 350 to 500°C was higher than when no free B was present. The rate of He release from powders that had B:C ratios of 3.6 and 4.5 did not vary significantly with irradiation temperature from 350 to 500°C. Annealing boron carbide with a B:C ratio of about 3.6 at temperatures as high as 2000°C did not lead to the solution of all the graphite C into the boron carbide structure. However, after irradiation at 350°C to 9% burnup of ^{10}B, the graphite was no longer present. Transmission electron microscopy revealed irradiation damage in boron carbide that appeared very similar to that observed in metal after very high fluence. A high density of black spots was observed, which was probably due to lattice strains from both displacement damage and the (n,α) reaction products. The damage appeared to be uniform, and no bubbles of He have yet been positively identified. (auth)

49507 (ORNL-TM-3300, pp 269-75) DEVELOPMENT OF FUEL ELEMENT FABRICATION. Adamson, G. M. Jr.; Martin, W. R. (Oak Ridge National Lab., Tenn.).

The irradiation experiment, designated PM capsule 1, was built and will be inserted into the HFIR to evaluate several properties that are believed to influence the performance of both ATR and HFIR fuel elements at high fission densities. (auth)

49508 (ORNL-TM-3416, pp 52-74) DEVELOPMENT OF ADVANCED FBR FUELS. (Oak Ridge National Lab., Tenn.).

In fuels and materials development program quarterly progress report for period ending March 31, 1971.

Approximately 500 pellets of (U,Pu)N to be irradiated in EBR-II have been fabricated during this quarter. Characterization of the fuel is about half completed. Machining of the fuel pellets will commence shortly. Nearly 200 pellets of UN were fabricated for use in sodium bonding technique development and for blanket pellets in the EBR-II irradiation pins. Comminution of (U,Pu)N by ball milling in hexane has been found to result in carbon contamination of the nitride but the presence of oxygen contaminant in the nitride powder results in carbothermic reduction during sintering and a loss of some of the carbon contaminant. A marked improvement in sintering of (U,Pu)N was observed for ball-milled powders. The Dumas method for nitrogen determination in nitrides has been developed to measure nitrogen in UN and U_2N_3 phases and should be easily applicable to (U,Pu)N. The dissolution vessel geometry was found to be important when dissolving samples of (U,Pu)N for the coulometric determination of the heavy metal. A reflux condenser is required in order to maintain high accuracy in the analysis. A tentative phase diagram for the Pu-Cr-N system has been determined in the range 790 to 1705°C. No ternary compound has been observed in the composition fields examined. Many of the components for the EBR-II capsule assemblies have been received and capsule fabrication is proceeding. Sodium bonding and NDT techniques for the (U,Pu)N irradiation pins are proceeding. (auth)

49509 (ORNL-TM-3416, pp 166-71) DEVELOPMENT OF FBR NEUTRON-ABSORBER MATERIALS. (Oak Ridge National Lab., Tenn.).

In fuels and materials development program quarterly progress report for period ending March 31, 1971.

X-ray scattering from irradiated crystals of boron carbide shows a composite of sharp and diffuse reflections. The lattice parameters calculated from the sharp maxima show an increase in the a and the c hexagonal indices; however, the lattice parameters calculated from the diffuse maxima show an increase in a and a decrease in c. Results of chemical analyses of the boron carbide powder in ORR capsules indicate that boron as elemental boron or as B_2O_3 was responsible for the higher gas release observed in some of the capsules. A problem exists in obtaining reliable burnup analyses for the irradiated boron carbide powders. Data on $^{10}B/^{11}B$ ratio indicate that the burnup is higher than that indicated by lithium analysis results. There are difficulties in obtaining a representative sample for the $^{10}B/^{11}B$ analysis since the present technique involves an extremely small sample from a powder where the burnup gradient could be relatively high. (auth)

49510 IMPROVEMENTS IN OR RELATING TO THE PRECIPITATION FROM SOLS OF MATERIALS CONTAINING METALS IN NON-ELEMENTAL FORM. Grimes, John Herbert; Lane, Edward Sydney (to United Kingdom Atomic Energy Authority). British Patent 1,231,385. 12 May 1971. Filed 4 Aug 1967.

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The sol-gel process is described for use in the production of metal oxide or carbide particles such as are used as nuclear reactor fuels; further applications are to the production of catalysts and ceramic materials, or materials for powder metallurgical processes. A mixture of the hydrous metal oxide sol and an organic polymer soluble in the sol is formed into a selected physical configuration and contacted with a precipitating agent to form a gel, retaining the selected configuration. The organic polymer may be selected from non-dehydrating polyhydroxy, polycarboxylic, or polyamine compounds, and the precipitating agent may be a base such as ammonia in liquid or vapor form. The gelled bodies may be formed by introducing the sol dropwise into the precipitating agent. Where the precipitating agent is a liquid it may contain an organic compound to increase its viscosity and thereby increase the time of the drops. The gelled bodies are then dried and heated to drive off the organic polymer. A list of suitable polymers is given. Details are given of the process as applied to uranium, zirconium, aluminum, titanium, and iron sols. Where carbides are desired carbon may be added to the sols before precipitation and the precipitated oxide converted to carbide by heating in an inert atmosphere. (UK)

49511 CONDITIONS OF FORMATION OF URANIUM OXYCARBIDES. Larin, A. A.; Vlasov, V. G.; Sedykh, N. Ya. J. Appl. Chem. USSR (Engl. Transl.); 43: No. 11, 2399-2403(Nov 1970).

Translated from Zh. Prikl. Khim.; 43: No. 11, 2369-74(Nov 1970).

Work conducted to determine the conditions for formation of uranium oxycarbides of various compositions and to obtain single-phase products is described. It was found that at high temperatures (in the region of 1850 to 1950°) and CO pressures in the range of 10^{-3} to 5×10^{-4} mm the interaction of uranium dioxide with carbon proceeds through oxycarbides; at 1750° and CO pressures of 10^{-1} to 10^{-2} mm oxycarbides phases of variable compositions, dependent on the heating time, are formed. It is shown by x-ray structure analysis results that the lattice parameter decreases with increasing oxygen content in the oxycarbide lattice, probably owing to a change in the nature of the chemical bond. (auth)

49512 METHOD FOR PREPARATION OF CARBONITRIDE NUCLEAR FUEL MATERIALS. Beatty, Ronald L.; Leitnaker, James M.; Notz, Karl J. Jr. (to United States Atomic Energy Commission). U. S. Patent 3,577,485. 4 May 1971. Filed 3 Feb 1969.

A rapid method for converting actinide oxide-carbon particles to actinide carbonitride is given which comprises contacting the actinide oxide-carbon particles with nitrogen in a fluidized bed furnace at elevated temperatures. (Official Gazette)

49513 STUDY BY γ RAY SPECTROSCOPY OF THE OPTIMAL CONDITIONS TO PRODUCE THIN FILMS OF TiO_2 BY REACTIVE CATHODE SPUTTERING. Laville-Saint-Martin, B.; Sens, J. C. (Ecole Superieure de Chimie, Mulhouse, France. Univ., Strasbourg). Nouv. Rev. Opt. Appl.; 2: No. 1, 63-7(Jan-Feb 1971). (In French).

A method for the preparation of titanium dioxide targets including ^{17}O by diode reactive sputtering on tantalum substrates was studied. For a constant initial rate of ^{17}O in the glow discharge, and the ^{17}O rate in the films depends on the choice of the experimental conditions. By studying a particular resonance of the $^{17}O(p,\gamma)^{18}F$ nuclear reaction, it was possible to determine the optimal conditions for the preparation of high-purity films, especially in the case of very thin films. (France)

49514 PREPARATION OF CARBON FIBERS FROM PETROLEUM TAR. Brie, M.; Lang, F. M. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Inform. Sci. Tech. (Paris); No. 155, 17-20(Jan 1971). (In French).

Pitch is an inexpensive raw material from which carbon fibers can be made. Various methods of processing pitch to obtain carbon fibers with mechanical properties lying between those of carbonized viscose fibers and fibers obtained from polyacrylonitrile are described. (auth) (France)

49515 PROCESS FOR PREPARING NUCLEAR FUEL PELLETS FROM URANIUM OR PLUTONIUM OXIDE OR MIXTURES THEREOF. Hagie, Laird Toothacre; Ryer, Chester Milledge (to General Electric Co.). British Patent 1,239,269. 14 Jul 1971. Priority date 13 Dec 1967, United States.

Fuel pellets consisting of an oxide of Pu or U or mixtures of these can be formed by cold pressing a quantity of the powdered oxide(s) so as to produce a self supporting fragile preform, placing the preform in a die, applying a pressure of from 4000 to 20,000 psi to crush the preform, and simultaneously or subsequently heating the preform in the die to a temperature of from 800° to 1300°C with the pressure and temperature maintained from 3 to 20 min. (B.L.M.)

49516 PROCESS OF PREPARING OXIDE MICROSPHERES. Chin, Jack; Norman, Roy E.; Thompson, James H (to Gulf Energy and Environmental Systems, Inc.). U. S. Patent 3,586,742. 22 Jun 1971. Filed 25 Nov 1966.

Oxide microspheres are prepared by injecting droplets of an aqueous metal oxide sol into a stream of organic liquid that is substantially immiscible with the sol. Gaseous ammonia is dissolved in the organic liquid, and contact between the liquid stream and the droplets is maintained for a sufficient time to permit the ammonia from the organic liquid to get the sol droplets. Uranium–thorium oxide microspheres can be produced using kerosene or carbon tetrachloride into which gaseous ammonia was bubbled. (Official Gazette)

49517 INVESTIGATIONS ON HYDROLYZIBLE CARBIDES. IV. PRODUCTION AND HYDROLYSIS OF MIXED CRYSTALS IN THE CaC_2–YC_2 SYSTEM. Hajek, B.; Brozek, V.; Popl, M. (Technische Hochschule, Prague). Collect. Czech. Chem. Commun.; 36: No. 4, 1537-45(Apr 1971). (In German).

The formation of mixed crystals in the system CaC_2-YC_2 was studied. The mixed crystals (Ca, Y)C_2 with a content of 33 and 66 mol% YC_2 were dissolved with distilled water and the gaseous products of hydrolysis were analyzed using gas chromatography and mass spectrometry. For comparison, an intimate CaC_2-YC_2 mixture was hydrolyzed. In contrast to hydrolysis of CaC_2 and YC_2 alone, the mixed carbides showed a higher content of saturated hydrocarbons. Hydrolysis of the solid carbide phase influences secondary hydration of the primarily produced acetylene. The type of hydrolysis of CaC_2 alone can produce a small amount of diacetyl with an equal volume of ethane and ethylene. (tr-auth)

49518 PREPARATION AND STUDY OF THE CERMET MOLECULAR URANIUM DIOXIDE–MOLYBDENUM. Abate-Daga, G.; Amato, I. (Fiat, Turin). Rev. Int. Hautes Temp. Refract.; 8: No. 1, 25-30(Jan-Mar 1971). (In French).

A program on the development of new nuclear fuels led to the manufacture of molecular uranium dioxide–molybdenum cermet; it was prepared by the reduction of uranyl molybdate under hydrogen. The effect of temperature and sintering time on the densification was studied. The following characteristics of the sintered pellets were determined: the volume of the open and closed porosity, the microstructure, and the low-temperature thermal conductivity (50 to 500°C interval). The results are compared with those obtained for a cermet of the same composition prepared by mechanically mixing uranium and molybdenum dioxide powders. The most obvious difference between the different preparations is that of the dispersion, and, in consequence, the thermal conductivity. The experimental values obtained for the thermal conductivity are compared with those obtained using the Eucken relations for a physical model composed of spheres homogeneously distributed within the matrix. (France)

49519 SINTERING NUCLEAR FUELS: A PRACTICAL ASPECT. Ind. Process Heat.; 11: No. 5, 24-6(May 1971).

A furnace for the 550°C prefiring and 1700°C sintering of UO_2 pellets is described. The heat and gas barrier for preventing the volatilized binders and lubricants from entering the 1700°C section is described in some detail. Instrumentation, atmosphere controls, cooling, and operation are described. (D.L.C.)

49520 FORMATION OF METAL-CARBIDE LAYERS ON WEAR-STRESSED TOOLS. Ebersbach, G.; Mey, G. (VEB Werkzeugmaschinenkombinat, Karl-Marx-Stadt, Ger.). pp 287-94 of Diffusion in Metallischen Werkstoffen. Leipzig; VEB Deutscher Verlag fuer Grundstoffindustrie (1970). (In German).

From seventh metal meeting; Dresden, Germany (1 Apr 1970). See CONF-700436.

Methods for the deposition of layers of carbides of Ti, Cr, and V on the surfaces of steel were developed. The formation of the carbide layers was described and their structure and properties were discussed. (J.S.R.)

49521 METHOD FOR PREPARING MICROSPHERES. Flack, Herbert Paul; Sanchez, Moises Gali; Lamberth, Charles Thomas Jr. (to W. R. Grace and Co.). British Patent 1,232,123. 19 May 1971. Priority date 31 Jan 1968, United States.

A method for producing microspheres of an oxide of one or more metals selected from the actinides, lanthanides, Zr, Be, and Yt comprises passing an aqueous feed made up of an aquasol of the metal oxide or a dissolved salt of the metal in the form of droplets into a bath containing a liquid medium having essentially

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no solubility for water and containing also either (1) NH_3 dissolved in the liquid medium, (2) an NH_3-releasing agent dissolved in the liquid medium, or (3) a layer of aqueous NH_3 beneath the layer of the liquid medium to gel the feed droplets with NH_3 while fresh NH_3 is introduced into the bath. After the recovery of the gel particles from the bath, they are dried and sintered. (B.L.M.)

49522 PROCESS FOR THE PRODUCTION OF A FUEL AND/OR BREEDER ELEMENT FOR NUCLEAR REACTORS. (to Kernforschungsanlage Juelich GmbH). British Patent 1,233,331. 26 May 1971. Priority date 19 Apr 1968, Germany.

A process is described for the production of a nuclear fuel element and/or a breeder element from a nuclear fuel and/or breeder material in the form of particles coated with pyrolytic carbon, carbides, or oxides to prevent the escape of gaseous or solid fission products. The coated particles with the addition of furfuryl alcohol are mixed with a carbide and/or a carbide-forming metal of high conductivity in powder form, and the mixture is consolidated into a solid element by a subsequent heat treatment. (B.L.M.)

49523 ARTICLES COMPRISING URANIUM DIOXIDE AND METHODS OF PRODUCING SAME. (to Atomic Energy of Canada Ltd.). British Patent 1,223,966. 3 Mar 1971. Priority date 29 Mar 1968, Canada.

A method for producing an article, e.g., nuclear fuel element or a ceramic shape, of UO_2 comprises forming a compacted mixture of powders of UO_2 and U and/or Pu metal and incorporating into the mixture sufficient excess oxygen to produce stoichiometric UO_2 and PuO_2 on heating the mixture to elevated temperatures. The excess oxygen is incorporated by oxidizing the UO_2 prior to compacting to a higher composition of oxygen, such as UO_{2+x} where x represents the amount of excess oxygen necessary. The mixture of UO_{2+x} and U and/or Pu metal powders is compacted into a sheath to a density of 9.70 to 10.96 g/cc prior to sintering. (B.L.M.)

49524 SEE-THROUGH CERAMICS. Grimm, Nelson. Ind. Res.: 13: No. 5, 40-3(May 1971).

An account is given of the fabrication of a transparent ceramic, Yttralox (Y_2O_3), by sintering to high density. Optimum densification was obtained by adding thorium oxide to the Y_2O_3, and furnace conditions are controlled to obtain the cubic crystalline phase. Some possible applications of Yttralox's optical and refractory properties are discussed. Other developed and possible transparent ceramics are described: MgO, Irtran 2 (ZnS), CdS, heavy rare-earth oxides, etc. (D.L.C.)

49525 TRIAL PRODUCTION OF NUCLEAR FUEL FOR A HIGH-TEMPERATURE GAS-COOLED REACTOR. Manabe, Genroku (Furukawa Electric Co. Ltd., Tokyo). FAPIG (Tokyo): No. 59, 188-93(Nov 1970). (In Japanese).

Coated fuel particles of TRISO-type and fuel pellets made by bonding the particles with graphite powder have been produced in trial for a high-temperature gas-cooled reactor. The particle core is UC_2 of diameter about 400 μ with 85% theoretical density produced by powder metallurgy. To apply coatings, the particles were placed in a reaction vessel, and were heated while stirred on Ar gas fluidizing floor. Then acetylene or CH_3SiCl_3 vapor carried by H_2 gas was passed through the vessel, to produce the coating of low-density carbon or silicon carbide respectively. Finally, to obtain the high-density carbon coating, propane gas was used. The pellets of particles in the graphite matrix were produced by injection technique, i.e., mixture of graphite powder, furfuryl alcohol, and maleic anhydride was injected into a layer of the particles. (Japan)

49526 PROCESS FOR MAKING NUCLEAR FUEL. (to W. R. Grace and Co.). British Patent 1,237,011. 30 Jun 1971. Priority date 21 Jun 1967, United States.

The process comprises impregnating porous microspheres (of UO_2 or other actinide oxides) with a burnable neutron poison and then sintering the microspheres to densify them. The microspheres may also contain Zr, Y, Al, or Mg ions for improved physical properties. The impregnant may be a solution of $Gd(NO_3)_3$, $Sm(NO_3)_3$, or boric acid. Several examples of the preparation of UO_2 microspheres and their impregnation are given. (D.L.C.)

49527 PROCESS FOR THE DRY TREATMENT OF CERAMIC UO_2 GRANULAR NUCLEAR FUEL. (to Nukem Nuklear-Chemie und-Metallurgie GmbH). French Patent 2,001,113. 26 Sep 1969. Priority date 1 Feb 1968, Germany. (In French).

A process for the dry treatment of ceramic UO_2 fuel grains was proposed in which the ceramic UO_2 is transformed by air oxidation or by treatment with high-temperature steam into fine particles of U_3O_8 or UO_2 and this powder is mixed directly with the UO_2 frittable powder. The UO_2 is first screened. The oxidation of the non-fritted ingots, the fritted tablets, and the polishing mud is carried out at a temperature of 350 to 500°C in an oxidizing atmosphere, preferably air. The U_3O_8 produced by oxidation is reduced by hydrogen and is mixed, together with the UO_2 powder with initial frittable UO_2 powder. The UO_2 polishing mud is processed with steam between 150 and 250°C in order to remove the polishing oil. The polishing mud is dried in air at 100°C. (tr-auth)

49528 YTTERBIUM DODECABORIDE. Odintsov, V. V.; Paderno, Yu. B. (Inst. of Problems in Materials Sciences, Kiev). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 2, 294(Feb 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 2, 333(Feb 1971).

The preparation and properties of YbB_{12} are described. Data are included on temperature dependencies of YbB_2 electric conductivity and electronic spectrum. (J.R.D.)

49529 PYROLYTIC GRAPHITE. Smith, William H.; Leeds, Donald H. (Super-Temp Co., Santa Fe Springs, Calif.). pp 139-221 of Modern Materials. /Gonser, Bruce W. (ed.). New York; Academic Press, Inc. (1970).

A comprehensive survey of the subject of pyrolytic graphite is presented with 67 references being cited. The survey covers manufacturing, properties, applications, and other forms of pyrolytic graphite. (B.L.M.)

Properties Evaluations

Refer also to abstracts 49447, 49997, 49999, 50007, 50017, 51194, and 51251.

49530 (AD-717983) CHEMICAL STRENGTHENING OF CERAMIC MATERIALS. Summary Report, January 7-December 6, 1970. Kirchner, Henry P.; Buessem, W. R.; Gruver, Robert M.; Platts, Dennis R.; Walker, Ralph E. (Ceramic Finishing Co., State College, Pa.). 6 Dec 1970. Contract N00019-70-C-0418. 166p. NTIS.

In polycrystalline ceramics subjected to external forces fracture originates at surface flaws. Compressive surface layers prevent surface flaws from acting to cause failure. Therefore, compressive surface layers can be used to obtain improved strengths. In the investigation, treatments were applied to alumina, zirconium diboride, silicon carbide and zircon porcelain bodies. The methods used included quenching, glazing and quenching, formation of low expansion surface layers by reaction with powders at high temperatures, and chemical vapor deposition of low expansion surface layers. Glazing and quenching improved the strength of 96% alumina body. Preliminary evidence of strengthening by chemical vapor deposition of surface layers was obtained. Other properties of the treated materials that were determined included the elevated temperature flexural strength and the impact resistance. Fractographic techniques were used to investigate the fracture mechanisms and the fracture origins. Residual stress profiles were calculated and were used to calculate the outer fiber stress and the stress at the volume flaws. (auth) (USGRDR)

49531 (BNWL-SA-3838) THERMAL EXPANSION COEFFICIENTS OF GRAPHITE CRYSTALS. Morgan, W. C. (Battelle Pacific Northwest Labs., Richland, Wash.). [1970]. Contract AT(45-1)-1830. 16p. (CONF-710612-2). Dep. NTIS.

From tenth biennial conference on carbon; Bethlehem, Pa. (27 Jun 1971).

Graphite crystal expansions were derived as a function of temperature using the theoretical relationships of Riley; the resultant equations provide reasonable fits to the measured lattice expansion data over the temperature range 300 to 3000°K. (auth)

49532 (LA-tr-71-65) A FEW PROPERTIES OF URANIUM MONO-CARBIDE WITH SMALL ADDITIONS OF ZIRCONIUM. Bocker, S.; Boucher, R. Translated for Los Alamos Scientific Lab., N. Mex.), from J. Nucl. Mater.; 33: 30-9(1969). 13p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 51096.

49533 (RD/B/N-1951) WEAR RATE OF BONDED MOLYBDENUM DISULPHIDE. Parry, A. A.; Williams, M. E. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Mar 1971. 15p. Dep. NTIS (U. S. Sales Only).

A series of experiments covering a wide range of sliding conditions was performed to examine the wear behavior of coatings of molybdenum disulphide bonded with sodium silicate. The experiments were conducted in dry carbon dioxide at room tem-

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perature. It was found that wear, rather than fatigue, was probably the predominant mode of failure, so that the concept of "specific wear rate" (volume worn per unit sliding distance per unit load) could be applied to this type of coating. By treating the results statistically a value of the specific wear rate which would be bettered by 90% of coatings was calculated. This may be used in design calculations. (auth) (UK)

49534 TRANSITION METAL CARBIDES AND NITRIDES. Toth, Louis E. Refractory Materials. A Series of Monographs. Volume 7. New York; Academic Press Inc. (1971). 290p. $16.50.

Recent developments in transition metal carbide and nitride research are presented. Information is given concerning: general properties, preparation, and characterization; crystallography; phase diagrams; thermodynamics; mechanical properties; electric and magnetic properties; superconducting properties; and band structure and bonding. (G.M.C.)

49535 MEASUREMENT TECHNIQUES FOR CARBON FIBERS AND THEIR COMPOSITES. Degas, P.; Micaud, J. C.; Schill, R. (CEA, Saclay, France). Bull. Inform. Sci. Tech. (Paris); No. 155, 43-52(Jan 1971). (In French).

The study of carbon fibers and their composites is hindered by difficulties due to the geometry and anisotropy of these materials. Conventional measurement techniques must therefore be modified. The methods used to determine the thermal expansion coefficients, thermal conductivity, electrical resistivity, and magnetic susceptibility, are reported. Various mechanical tests to determine the elastic and shearing moduli, the internal friction, and fatigue phenomena, are described. (auth) (France)

49536 PREPARATION AND PROPERTIES OF CARBON FIBERS WITH A HIGH YIELD STRENGTH. Moutaud, G. (Societe Le Carbone Lorraine, Paris). Bull. Inform. Sci. Tech. (Paris); No. 155, 7-15(Jan 1971). (In French).

The desired properties of reinforcement materials are outlined. Two types of carbon fiber are used at present: ex-cellulose fibers and ex-polyacrylic fibers. The properties of filaments and fiber-epoxy-resin composites reveal new problems. (auth) (France)

49537 METALS REINFORCED BY CARBON FIBERS. Gremion, R. (Societe Le Carbone Lorraine, Paris); Moreau, M.; Jouquet, G.; Mottet, P. Bull. Inform. Sci. Tech. (Paris); No. 155, 53-8(Jan 1971). (In French).

Composite materials combining carbon fibers with nickel, and aluminum, and magnesium alloys were prepared. Various manufacturing techniques were employed: infiltration of molten metal, sintering of powder, hot pressing of metal coated fibers. The mechanical properties of these materials, measured at room temperature or at 450°C, were comparable for both long and short fibers. The elastic moduli measured conform reasonably well with the law of mixtures, discrepancies being due to porosity. The strengths, although superior to those of the corresponding metals, are less than those predicted. A significant improvement is made by coating the fibers with a protective layer. (auth) (France)

49538 SOME ASPECTS OF ELECTROCHEMICAL THERMODYNAMICS AND EQUILIBRIUM DIAGRAMS FOR AQUEOUS SYSTEMS AT ELEVATED TEMPERATURES AND FOR SIMPLE MOLTEN SALT SYSTEMS. Lewis, Derek (Aktiebolaget Atomenergi, Stockholm. Royal Inst. of Tech., Stockholm). J. Inorg. Nucl. Chem.; 33: No. 7, 2121-40(Jul 1971).

An approach is briefly described to the electrochemical thermodynamics of corrosion, mass-transport, and deposition processes in nuclear power-plant working on the water-cycle and in homogenous molten-salt reactors. Diagrams are introduced, based on the parameter $pe = (RTF^{-1} \ln 10)^{-1} \cdot {}_T\epsilon$ instead of the usual redox potential, ${}_T\epsilon$, that are useful for illustrating equilibrium data for aqueous systems at elevated temperatures (above 100°C) and for molten salts. (auth) (UK)

49539 CREEP BEHAVIOR OF HOT ISOSTATICALLY PRESSED GRAPHITE. Zukas, E. G.; Green, W. V. (Los Alamos Scientific Lab., N. Mex.). Carbon; 9: No. 3, 341-4 (May 1971).

Specimens of two commercial graphites were hot-isostatically pressed at 2700°C to >95% theoretical density. These were compared in creep to unpressed specimens from the same artifact. The creep curves were similar in shape. Strengths and creep ductilities were equal, and stress and temperature dependences of the creep rate were identical. The pores and cracks present in the original material did not seal during the densification process. The creep deformation modes were the same. (auth) (UK)

49540 EFFECT OF GASES ON PARTICLE EMISSION DURING THE HEATING OF GRAPHITE. Lieberman, Morton L. (Sandia Labs., Albuquerque, N. Mex.). Carbon; 9: No. 3, 345-7(May 1971).

Graphite, heated to about 3000°K, not only vaporizes but also emits solid particles. The possibility of gaseous impurities in the pores being the cause of the phenomena is considered. Calculations are performed for H_2. (UK)

49541 VISCOELASTIC REPRESENTATION OF THE MECHANICAL BEHAVIOR OF RVD GRAPHITE AT ELEVATED TEMPERATURES. Pugh, C. E. (Oak Ridge National Lab., Tenn.). Carbon; 9: No. 3, 327-40(May 1971).

A set of constitutive equations is developed to describe the time-dependent mechanical behavior of RVD graphite at temperatures from 3500 to 5000°F. The relations are based upon a transversely isotropic linear viscoelastic model with temperature-dependent parameters. This model is shown to be applicable for stress levels up to one-half the nominal ultimate stress values for the material. Predictions of these equations are compared with experimental measurements from short-time stress–strain tests, creep tests, and relaxation tests. (auth) (UK)

49542 RELATIONS BETWEEN THE STRUCTURE AND THE MECHANICAL PROPERTIES OF FLUIDIZED-BED PYROLYTIC CARBONS. Kaae, J. L. (Gulf General Atomic Co., San Diego, Calif.). Carbon; 9: No. 3, 291-9(May 1971).

The mechanical properties of fluidized-bed pyrolytic carbons derived from a number of hydrocarbon gases are related to the density, apparent crystallite size, and degree of preferred orientation. For isotropic carbons with constant crystallite size, the Young's modulus and the fracture stress increase with increasing density. Over a considerable range of density, the Young's modulus follows the relation $E = E_0 \exp(-BP)$ where E_0 and B are constants and P is the fractional porosity. Over a similar range of density, the increase in fracture stress is apparently related to the changing volume fraction of the pores and not to changes in the critical flaw size or the work of fracture. For isotropic carbons with constant density, the Young's modulus and fracture stress increase with decreasing crystallite size possibly due to crosslinking either between crystallites or between layer planes. For carbons with constant density and crystallite size, the Young's modulus increases and the fracture stress decreases with increasing anisotropy. The variation of the Young's modulus shows fair agreement with the variation expected from constant-stress crystallite averaging, while the variation of the fracture stress might be explained by a change in the mode of fracture propagation. (auth) (UK)

49543 RESEARCH ON STRONTIUM URANATES. Brisi, C.; Montorsi, M.; Acquarone Burlando, G. (Politecnico, Turin). Rev. Int. Hautes Temp. Refract.; 8: No. 1, 37-42(Jan-Mar 1971). (In French).

Products obtained by the air calcination of mixtures of strontium oxide and uranium oxide were studied. Five uranates were identified with the formulas: Sr_3UO_6, Sr_2UO_5, $Sr_3U_2O_9$, $SrUO_4$, and $SrU_4O_{12.8}$. At 1,370°C, Sr_2UO_5 decomposes giving a mixture of Sr_3UO_6 and $SrUO_{4-x}$; $Sr_3U_2O_9$ is stable only between 1,170 and 1,325°C. At 1,230°C, $SrUO_4$ loses oxygen transforming into the rhombohedral form, $SrUO_{4-x}$. Between this phase and $Sr_2U_3O_{11}$, a complete series of solid solutions, stable in air, are obtained at temperatures which increase with the U/Sr ratio. The zone of the system, rich in uranium, is characterized by the presence of a phase, $SrU_4O_{12.8}$, which, at 1,120°C produces a mixture of $Sr_2U_3O_{11}$ and U_3O_8. Above 1,330°C, the formation of a fluorine structure phase, $Sr_{0.2}U_{0.8}O_{2.05}$ takes place. (France)

49544 UNIDIRECTIONALLY SOLIDIFIED Ti–TiB AND Ti–Ti_5Si_3 EUTECTIC COMPOSITES. Crossman, F. W. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.); Yue, A. S. Met. Trans.; 2: No. 6, 1545-55(Jun 1971).

Induction melting and electron beam melting techniques were employed in the production of unidirectionally solidified eutectic composites of Ti–1.7 wt % B and Ti–8.5 wt % Si. The grown eutectics were reinforced by 7.7 vol % of TiB fibers and 31 vol % of Ti_5Si_3 fibers respectively. Controlled dendritic solidification of a hypereutectic composition of Ti–12 wt % Si was also accomplished. Tensile, compressive, creep, and stress rupture specimens were cut from the eutectic composites and tested with reinforcing fibers parallel to the load axis. Ti–TiB eutectic was found to have less than the critical volume fraction of fibers necessary for reinforcement, while Ti–Ti_5Si_3 composite attained a compressive yield strength of 275,000 psi and a compressive Young's modulus of 30×10^6 psi after heat treatment. The 500 and 4000-hr stress rupture properties of Ti–Si eutectic were superior to com-

mercial titanium alloys at 1000 and 1200°F. The minimum creep rate of Ti–Ti_5Si_3 eutectic composite was lower than all other titanium alloys at 1000°F. Tensile, compressive, and creep properties of the Ti–8.5 wt % Si eutectic are discussed in terms of the current theories of composite behavior. (auth)

49545 QUENCH TESTING OF CERAMICS. Pryor, A. W.; Rotsey, W. B.; Wood, B. R.; Turner, D. N.; Smith, P. D. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). J. Aust. Ceram. Soc.; 7: 7-11(May 1971).

Quenching of beryllia, alumina, and zirconia was performed by plunging spheres of these ceramics into baths (giving surface heat transfer coefficient $H \sim 1$ W $cm^{-2}C^{-1}$) or by rolling the spheres through a high-pressure water spray (giving $H \sim 20$ W $cm^{-2}C^{-1}$). Values of nondimensional maximum stress (δ_{max}) are obtained for both values of H. For low-conductivity ceramics it should be possible to calculate δ_{max} to an accuracy of around 5%, but for a high-conductivity ceramic such as BeO the accuracy will be about 20%. Analytical solutions for δ_{max}, and time to δ_{max}, are possible when thermal conductivity and specific heat of the specimen are independent of temperature. Calculated values (as a function of Biot number) are tabulated for the surface and center of a sphere and cylinder. (Australia)

49546 HOW HIGH-TEMPERATURE ANNEALING AFFECTS THE PROPERTIES OF BORON AND ALUMINUM NITRIDES. Prikhod'ko, L. I.; Samsonov, G. V. (Kiev Polytechnic Inst.). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 2, 204-6(Feb 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 2, 231-3(Feb 1971).

The changes in properties of BN and AlN after annealing at 1600 and 2000°C were studied. It is shown that after annealing at 1600°C, the powders react only weakly with water. In this case, BN displays an increase in particle size, pycnometric density, and ordering structure. Annealing at 2000°C evidently leads to a loss of structure ordering, and therefore impairment of the properties of the powder. (auth)

49547 THERMODYNAMICS OF HETEROGENEOUS GAS EQUILIBRIUM. III. GAS-PHASE COMPOSITION AND CHEMICAL TRANSPORT REACTIONS IN THE SYSTEM TUNGSTEN–OXYGEN. Neumann, G. M.; Gottschalk, G. (OSRAM-Studiengesellschaft, Munich). Z. Naturforsch.; 26a: No. 5, 882-7(May 1971). (In German).

Gas-phase composition of the heterogeneous system tungsten–oxygen was calculated by means of a computer program for temperatures ranging from 1500 to 3600°K and for initial oxygen pressures ranging from 1 to 10^{-6} atm. Results showed that at low temperatures (T < 1600 to 1900°K), solid tungsten oxide exists simultaneously with solid tungsten; therefore, in this temperature range, composition of the gas phase is independent of the initial oxygen pressure and depends only on the solid tungsten oxide. At temperatures above 2000°K, a chemical transport of tungsten takes place through its oxide in an open system. At lower temperatures, transport is directed from cold toward hot; at very high temperatures, the direction is reversed. Both start of transport direction and reversal depend on initial oxygen pressure. Computer data are confirmed by experimental results reported in the literature. (tr-auth)

49548 FEATURES OF THE LUMINESCENCE OF CRYSTALLINE URANYL PHOSPHATES AND ARSENATES. Gaevoi, G. M.; Druzhinin, A. N.; Kizel, V. A.; Krasilov, Yu. I.; Ellert, G. V. (Inst. of General and Inorganic Chemistry, Moscow. Moscow Physical-Technical Inst.). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 2, 227-31(Feb 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 2, 255-61(Feb 1971).

The spectra and rates of luminescence decay of crystalline uranyl phosphates and arsenates were investigated. On the basis of an analysis of the frequency of holosymmetric vibrations of the uranyl ion, the structure of the coordination sphere of uranyl and the nature of the donor-acceptor uranyl-ligand bonds are discussed. The broadening of the lines along the spectrum, which is associated with the high rate of redistribution of the vibrational energy of uranyl are examined. (auth)

49549 URANIUM AND PLUTONIUM CARBIDES WITH TUNGSTEN ADDITIVE. Ervin, Guy Jr. (Atomics International, Canoga Park, Calif.). Amer. Ceram. Soc. Bull.; 50: No. 8, 659-61(Aug 1971).

UC–W alloys can be prepared with 2.0 wt % W in solid solution in the monocarbide lattice, and by intermediate temperature annealing, a substantial portion of the dissolved tungsten can be precipitated as fine particles. A phase diagram was proposed which accounts for the observed behavior. On the basis of incomplete studies the (U, Pu) C–W system is similar, and it should be possible to prepare tungsten-containing uranium plutonium carbide and perform a swelling test similar to that performed earlier on tungsten-containing uranium carbide. (auth)

49550 MODERN MATERIALS. Gonser, Bruce W. (ed.). Advances in Development and Applications, Volume 7. New York; Academic Press, Inc. (1970). 364p. $18.50.

This book is divided into 6 chapters dealing with the following: particleboard, acoustical materials, materials produced by electrical discharges, pyrolytic graphite, materials for temperature measurement, and thermal insulation systems. A separate abstract has been prepared for the chapter on pyrolytic graphite. (B.L.M.)

For an abstract of an individual chapter see: 49529.

Structure and Phase Studies

Refer also to abstracts 48737, 48757, and 50015.

49551 STRUCTURE AND SURFACE OF CARBON FIBERS. Donnet, J. B.; Dauksch, H. (CNRS, Mulhouse, France). Bull. Inform. Sci. Tech. (Paris); No. 155, 21-9(Jan 1971). (In French).

The most important results currently available on the structure of carbon fibers are examined. Results obtained with x-rays and electron microscopy are presented. The area and appearance of the fibers are discussed. Studies of the surface demonstrated that it was, chemically, very inert. (auth) (France)

49552 X-RAY CRYSTALLOGRAPHIC STUDY OF THE α PHASE OF THE LUTETIUM–HYDROGEN SYSTEM BETWEEN 25 AND 540 DEG C. MEAN THERMAL EXPANSION COEFFICIENTS. Bonnet, Jacques; Daou, Joseph N. (Univ., Paris). Compt. Rend., Ser. C; 272: No. 20, 1697-1700(17 May 1971). (In French).

X-ray diffraction confirmed the existence of a transition in the α-phase of the Lu–H system near 170°C. The expansion coefficients due to the introduction of hydrogen at a constant temperature, and the thermal expansion coefficients of $LuH_{0.19}$ were determined. Both beneath and above 170°C, these coefficients present different characteristics. An interpretation is proposed on the basis of considerations relative to the stresses introduced by the interstitials distributed either in the tetrahedral interstices or in the octahedral interstices of the compact Lu atomic lattice. (auth) (France)

49553 DISLOCATION GLIDE IN UO_2 SINGLE CRYSTALS AT 1600°K. Sawbridge, P. T.; Sykes, E. C. (Central Electricity Generating Board, Berkeley, Eng.). Phil. Mag.; 24: No. 187, 33-53(Jul 1971).

A study was made of the effects of crystal axis orientation on the slip behavior, at 1600°K, of compressively deformed uranium dioxide single crystals. It is shown that the critical resolved shear stress for slip is anisotropic, and that the stress is sensitive to ionic configurations at the dislocation core. The morphology of slip on easy and difficult systems is markedly dissimilar and is a function of the ease with which dislocations are able to cross-slip from the primary glide plane. Slip in many cases is macroscopically non-crystallographic, deformation taking place by a composite slip process. In these cases slip on the primary system may be limited by dislocation interaction and the rate-controlling stress is that on the cross-slip plane. Dislocation multiplication and slip-band growth on {001} planes is limited by the unusual dislocation mobility behavior on these planes. Fracture can be initiated at the intersection of glide bands on {011}⟨011⟩ systems in UO_2. In this case the fracture plane is {001}. (auth) (UK)

49554 EXAMINATION OF CONTAMINATION ON THE SURFACE OF AN ALUMINA INSULATOR BY ELASTIC α-PARTICLE SCATTERING. Pierce, T. B.; Peck, P. F.; Cuff, D. R. A. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inorg. Nucl. Chem.; 33: No. 7, 1963-8(Jul 1971).

Elastic α-particle scattering provides an analytical method for the study of surface films. The principles of this technique are outlined, and illustrated by the study of a contaminating layer present on the surface of an alumina insulator. The nature and thickness of the contaminant was found from the energy distribution and intensity of the scattered α-particles; positive ion microprobe techniques were employed to obtain information about the distribution of the contaminant over part of the insulator surface. (auth) (UK)

49555 THERMAL PHASE EQUILIBRIA IN THE SYSTEM $CaO–Al_2O_3–SiO_2–ZrO_2$ AND THEIR APPLICATIONS TO STABIL-

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IZED SUPERFRACTORIES OF ZIRCONIUM. Solacolu, S.; Dinescu, R.; Barbulescu, A.; Keul, Mariane (Center of Chemical Physics, Bucharest). Rev. Roum. Chim.; 16: No. 4, 519-26(Apr 1971). (In French).

A preliminary phase study of the thermal equilibria in the system was carried out. The stabilization of cubic ZrO_2 by the isomorphous additions of oxides of alkaline earth metals was studied. The detail of two planes in the tetrahedron of four components at the level of 70% ZrO_2 and that of 35% ZrO_2 was studied by determining the properties on baking at 1650°C, i.e., the chemical components, the porosity, and the contraction. The zones and the limits of composition occupied by the superrefractories containing zirconium in the four-component system were established. The types of zirconium-containing superrefractories, the composition range of the different types, and their area of utilization were established. Likewise, the narrow correlation between the thermal phase equilibria of the system, the chemical constitution of the synthetic masses, and their properties after baking were determined. (tr-auth)

49556 CRYSTAL STRUCTURE OF U_7Te_{12} AND U_2O_2Te. Breeze, E. W.; Brett, N. H. (Univ. of Sheffield, Eng.). J. Nucl. Mater.; 40: No. 1, 113-15(Jul 1971).

X-ray diffraction was used which confirmed that U_7Te_{12} is isostructural with Th_7S_{12} and Th_7Se_{12} and U_2O_2Te with La_2O_2Te. U_7Te_{12} has a hexagonal unit cell with a = 12.309 Å and c = 4.242 Å. U_2O_2Te has a tetragonal unit cell with a = 3.9460 Å and c = 12.564 Å. X-ray diffraction intensities are given, and interatomic distances are calculated. (D.L.C.)

49557 MICROSTRUCTURE OF CARBON BLACKS IN PITCH-BONDED GRAPHITES AND STRUCTURAL CHANGES PRODUCED BY GAS–GRAPHITE OXIDATION REACTIONS. Jones, S. S.; Woodruff, E. M. (Battelle-Northwest, Richland, Wash.). Carbon; 9: No. 3, 259-64(May 1971).

Carbon blacks were found in binder regions of typical pitch-bonded graphites. These blacks appear to be part of the quinoline-insoluble fraction of the coal-tar pitch binder used in graphite manufacture. Replication techniques and direct transmission electron microscopy were used to determine the structure of the blacks and their deposition throughout the graphites as well as structural changes produced by thermal and electronically excited oxidation reactions. Individual blacks consist of roughly spherical arrangements of graphite crystallites with a radial orientation of c-axes. Outer crystallites appear so well joined that the blacks are quite resistant to thermal oxidation in contrast to the surrounding binder regions. However, the blacks are easily attacked by microwave-excited oxygen, and the oxidation process reveals minute impurity particles on and/or within the polygonal carbon-black structure. (auth) (UK)

49558 CRYSTALLITE PARAMETER CORRELATIONS FOR VARIOUS POLYMER CARBONS. Mitchell, S. J.; Thomas, C. R. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Carbon; 9: No. 3, 253-8(May 1971).

Correlations were established between the interlayer spacing d_c and crystallite diameter L_α and height L_c for a group of carbons prepared from a number of organic precursors. The correlations are valid over a range of graphite character from highly crystalline materials with d_c = 3.37 Å to microcrystalline carbons where $d_c \geq 4.1$ Å. On this basis, the arbitrary classification of precursors into graphitising and nongraphitising types is seen as a statement of the two extremes of a continuous spread of graphitising behaviour. (auth) (UK)

49559 NITROGEN–NITRIDE REACTIONS IN MOLTEN U–Sn ALLOYS. Anderson, R. N.; Parlee, N. A. D. (Stanford Univ., Calif.). Met. Trans.; 2: No. 6, 1599-1604(Jun 1971).

The nitride formation and dissociation reactions in 2 to 18 % (uranium) U–Sn alloys have been studied over the temperature range of 600 to 1600°C by a modified Sieverts technique. Two different reactions occur depending upon the temperature: U_2N_3 being formed in the lower part of the temperature range and UN in the higher. The equilibrium data on the UN reaction make it possible to provide the standard free energy of this reaction as follows with a reasonable degree of confidence: $UN(s) = U(pct) + \frac{1}{2} N_2(g)$; $\Delta G° = +35{,}350 - 20.0\ T$. Less reliable data on the U_2N_3 reaction can be represented by the following standard free energy equation: $U_2N_3(s) = 2U(pct) + \frac{3}{2} N_2(g)$; $\Delta G° = +3890 + 7.5\ T$. Activity data on uranium have been derived. (auth)

49560 NICKEL AND COBALT EUTECTIC ALLOYS REINFORCED BY REFRACTORY METAL CARBIDES. Lemkey, F. D.; Thompson, E. R. (United Aircraft Research Labs., Hartford, Conn.). Met. Trans.; 2: No. 6, 1537-44(Jun 1971). (CONF-691062-2).

From Symposium on properties of aligned eutectic composites; Philadelphia, Pa. (13 Oct 1969).

Eutectiferous behavior was observed within pseudobinary joints between the monocarbides of Group IVa and Va metals with nickel and cobalt. Coupled two phase growth normal to a macroscopically planar liquid-solid interface was noted even though the various carbide phases grew in a faceted manner. The composite structures formed by unidirectional freezing consisted of either a cobalt or nickel matrix with an aligned whisker-like or three-sided lamellar carbide dispersion. The nickel–niobium monocarbide system was found to be stronger than TD-nickel in tension from room temperature to 2100°F. Repeated fracture along the length of individual carbide whiskers was observed during tensile straining. This behavior, which is nontypical of previous eutectic whisker composites, was interpreted in terms of the distribution in whisker strengths. The strength of extracted NbC whiskers measured in bending was found to approach the theoretical failure stress. Creep rupture test results further indicated that reinforcement of a weak nickel or cobalt matrix with aligned monocarbide whiskers provides a new type of material for use at elevated temperatures. (auth)

49561 PHASE TRANSFORMATIONS INVOLVING INTERSTITIAL ORDERING IN THE VANADIUM–NITROGEN SYSTEM. Potter, Donald Irwin. Urbana, Ill.; Univ. of Illinois (1970). 190p. University Microfilms Order No. 71-14,913.

Thesis.

Alloys of vanadium containing up to 14.0 atomic percent nitrogen were examined in the as-quenched and aged conditions. X-ray diffraction showed the room temperature material to be body centered cubic for nitrogen contents of less than 6.0% and body centered tetragonal for nitrogen contents greater than 7.4%. Electrical resistivity, measured during quenching, also indicated a change in behavior near 6.0% nitrogen. Transmission electron microscopy was used to follow the progress of aging in alloys containing less than 6.0% nitrogen. When aged, these alloys contained a disc shaped precipitate whose habit plane was determined to be {100}. The matrix remained cubic and the interstitial nitrogen atoms in the matrix were not ordered. The structure of the precipitate was determined from selected area diffraction patterns and consisted of an ordered array of nitrogen atoms in a body centered tetragonal vanadium sublattice. The unit cell of the superlattice, i.e., vanadium sublattice plus nitrogen sublattice, enclosed sixteen vanadium sublattice cells, being 4 × 4 × 1 such cells. The nitrogen sublattice was found to be base centered orthohombic. The superlattice cell, which is enclosed by the nitrogen sublattice cell, has the same lattice constants. Stoichiometrically the compound corresponds to $V_{16}N$. It is shown that the nitrogen atoms occupy octahedral interstitial sites rather than the tetrahedral sites predicted from theoretical considerations. Alloys containing greater than 6.0% nitrogen transformed to a banded structure during radiation quenching. The vanadium sublattice showed tetragonal distortion with c/a varying from 0.974 in a 7.4% alloy to 0.955 in a 10.0% alloy. X-ray Laue patterns together with two surface analysis showed that adjacent bands were twin related across {110} twin planes, which were the boundaries between bands. There was a fine banding (~100 Å) within the main bands. This occurred on the other set of {110} twin planes of the tetragonal system as well as the remaining {110} planes which are not twin planes in the tetragonal system. Electron diffraction showed that the nitrogen atoms in this structure are ordered. A macroscopic shape change as well as audible clicking accompanied the transformation in alloys containing between 6.0 and 8.0% nitrogen. (Diss. Abstr. Int., B)

49562 STRUCTURE OF In_2O_3 FILMS MADE BY REACTIVE CATHODE SPUTTERING. Vainshtein, V. M.; Fistul, V. I.; Nikolaeva, I. N. Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 2, 299-301(Feb 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 2, 338-40(Feb 1971).

Measurements of carrier mobility and x-ray structural analysis were used to evaluate film structure of sputtered In_2O_3. It was found that In_2O_3 film structure depends on deposition rate and energy parameters. (J.R.D.)

49563 ORDERING OF INTERSTITIAL NITROGEN IN VANADIUM. Potter, D. (Union Coll., Schenectady, N. Y.); Altstetter, C. Contract AT(11-1)-1198. Acta Met.; 19: No. 9, 881-6 (Sep 1971).

The crystal structure of precipitates occurring in dilute solutions (0 to 6 at.%) of nitrogen in vanadium has been identified from electron diffraction patterns. The stoichiometry of the precipitate is approximately that of $V_{16}N$, this having been established by volume fraction measurements on aged samples. The structure consists of a base-centered orthorhombic array of nitrogen atoms, which enclose a 4 × 4 × 1 array of b.c.t. vanadium atom unit cells,

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the complete assemblage constituting the superlattice unit cell. It is shown that the nitrogen atoms occupy the octahedral interstitial sites. A type of twinning in these alloys is identified, wherein the observed twin planes are twin planes for the nitrogen sublattice but are mirror planes, hence, not twin planes, for the vanadium atom sublattice. The twin planes of the vanadium sublattice, those across which the tetragonal axis changes orientation, were not observed in any of the precipitates. (auth)

49564 EUROPIUM SELENIDES. Sadovskaya, O. A.; Yarembash, E. I.; Naginaev, E. N. (Inst. of General and Inorganic Chemistry, Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 2, 284-5(Feb 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 2, 323(Feb 1971).

Phases in the system Eu–Se at 49 to 100 at.% Se were investigated. Results of DTA and x-ray analyses of these phases are tabulated. (J.R.D.)

49565 TERNARY BORIDE WITH CHROMIUM CARBIDE ($Cr_{23}C_6$) STRUCTURE IN THE SYSTEM Co–In–B. Schoebel, J.-D.; Stadelmaier, H. H.; Smith, T. R. (North Carolina State Univ., Raleigh). Metall; 25: 10-12(Jan 1971). (In German).

The cobalt side of the Co–In–B system was described with the help of a melting surface projection and an isotherm section at 800°C. An incongruent melting boride with chromium carbide structure occurs and its composition at 76.7 at. % Co, 2.6 at. % In, and 20.7 at. % B is $Co_{22.1}In_{0.9}B_6$. The boride shows no homogeneity range. Its lattice constant is a = 10.567 ± 0.001 Å. (tr-auth)

Radiation Effects

Refer also to abstracts 48758, 49364, 49460, 49491, 51082–51084, 51175, and 51247.

49566 (BMI–1906) REVIEW OF OUT-OF-PILE AND IN-PILE CREEP OF CERAMIC NUCLEAR FUELS. Seltzer, Martin S.; Perrin, James S.; Clauer, Allen H.; Wilcox, Benjamin A. (Battelle Memorial Inst., Columbus, Ohio). Jul 1971. Contract W-7405-eng-92. 72p. Dep. NTIS.

Diffusion and creep data are compiled for UO_2, UO_2–PuO_2, UO_2–ThO_2, UO_2–ZrO_2, BeO–UO_2, ThO_2, UC, UN, and mixed uranium–plutonium carbonitride; results of out-of-pile and in-pile creep studies of these materials are discussed. Formulations are derived relating creep rate to stress, temperature, and material parameters. The activation energy for creep of UO_2 decreases with increasing oxygen excess. For polycrystalline material, the stress dependence of the UO_2 creep rate increases gradually from a stress exponent of 1 in the low-stress range to a stress exponent of 4 to 5 in the high-stress region. UC creep rates depend upon carbon concentration; thus the diffusion data suggest that uranium diffusion is the rate-controlling process. The creep process in UN may involve uranium volume diffusion. A creep mechanism such as grain-boundary sliding or Nabarro–Herring creep is indicated for UO_2 creep tested in-pile above 1000°C at a fission rate of 1.2×10^{13} fissions/(cm^3) (sec). A model is suggested where the UO_2 in-pile creep rate is always greater than the out-of-pile creep rate, at least to temperatures of about 1200°C for fission rates greater than 1×10^{13} fissions/(cm^3) (sec). In a similar manner, the creep rate of UC in-pile is substantially enhanced over the creep rate out-of-pile. (auth)

49567 (EURFNR–934) COMPATIBILITY BETWEEN VANADIUM ALLOYS AND OXIDES AND CARBIDES UNDER IRRADIATION. Donner, S.; Schumacher, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). May 1971. 17p. (KFK–1410; CONF-710326–1). Dep. NTIS (U. S. Sales Only).

Work Performed under United States–Euratom Fast Reactor Exchange Program.

From third meeting on fuel and materials; Brussels, Belgium (18 Mar 1971).

Corrosion problems arising from the use of vanadium and its alloys in a gas-cooled fast reactor with mixed oxide and mixed carbide fuels respectively were studied. Calculations were made of the amounts of oxygen or carbon respectively which attacks the cladding. It is taken into account that oxygen and carbon are released by the fission processes and by conversion of uranium in plutonium. The calculations indicate that a major deterioration of mechanical properties of the vanadium cladding can be expected if mixed oxide fuel is used because oxygen transport by thermal diffusion through the CO/CO_2-gas phase occurs due to the temperature gradient in the fuel element. A statement with respect to the carbides is more difficult since only incomplete thermodynamic data exist. With the data available it is concluded that no considerable transport process is likely to occur and no additional carbon is delivered to the cladding by fission processes. Therefore, in reactor fuel elements with carbide fuel no increase of the reaction with the vanadium cladding is expected in comparison to the effect found in the isothermal out-of-pile experiment. (auth)

49568 (GA–10468) HTGR FUEL DESIGN AND IRRADIATION PERFORMANCE. Luby, C. S.; Harmon, D. P.; Goeddel, W. V. (Gulf General Atomic Co., San Diego, Calif.). 5 Jan 1971. Contract AT(04-3)-167. 37p. (CONF-701102–23). Dep. NTIS.

From Meeting of the American Nuclear Society; Washington, D. C. (15 Nov 1970).

HTGR fuel materials demonstrated excellent performance in high-temperature, high-burnup, and high-exposure irradiation tests. These successful test results reaffirm the HTGR fuel element design of bonded rods of coated particle fuel in hexagonal graphite blocks. The multilayered BISO and TRISO coated particles exhibited excellent irradiation performance in over 275 successful tests at fuel burnups up to 75% FIMA (heavy metal), fast-neutron fluences up to 8.7×10^{21} n/cm^2 (E > 0.18 MeV), and temperatures up to 1325°C. These coated particles are designed using mathematical stress-analysis models, which correlate well with the irradiation test results. Fuel rods, which are beds of coated particles bonded together with a carbonaceous matrix, demonstrated good integrity and dimensional shrinkage in 25 irradiation tests at fast fluences up to 7.0×10^{21} n/cm^2 and temperatures up to 1400°C. Irradiation testing of the reference needle-coke graphite showed it to have adequate dimensional and structural stability over the full range of HTGR operating conditions. (auth)

49569 (IDO-ITR–100) TRANSIENT IRRADIATION OF ¼-INCH OD STAINLESS STEEL CLAD OXIDE FUEL RODS TO 570 CAL/G UO_2. McClure, J. A.; Siefken, L. J. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Oct 1968. Contract AT(10-1)-205. 47p. Dep. NTIS.

A series of seven transient fuel performance tests were conducted on SPX-type fuel rods in the Capsule Driver Core (CDC). The SPX rods tested contained 3 and 10% enriched pelletized UO_2 clad with ¼-inch OD annealed stainless steel. Single rods encapsulated in stagnant water at ambient temperature and atmospheric pressure were subjected to transient energy depositions in the range from about 200 to 570 cal/g of UO_2. The tests were performed primarily for the purpose of obtaining scoping information on both the transient energy deposition required to cause clad failure, and on the consequences associated with tests where failure occurred. Damage to the fuel rods ranged from discoloration and slight cladding growth at 200 cal/g to complete fragmentation of the fuel and cladding at 572 cal/g. Cladding failure in the form of melting was first observed at 276 cal/g. For energy depositions greater than about 400 cal/g, failure occurred prior to melting, indicating that internal pressure contributed to the failure. Metal-water reaction of the cladding was not significant prior to melting. The reaction extent increased as a function of energy deposition for energies in excess of that required to melt the cladding. Transient pressures and mechanical energy generation were relatively low over the range of energies investigated. No detectable pressures were generated for energy depositions to about 275 cal/g. At 572 cal/g, the maximum measured pressure was 550 psi, and the nuclear to mechanical energy conversion was ≃0.4%. (auth)

49570 (IN-ITR–115) CARBON IMPURITY IN UO_2 AND ITS EFFECTS ON CLADDING SWELLING DURING POWER BURSTS. Lussie, W. G.; Miller, R. W. (Idaho Nuclear Corp., Idaho Falls). Jul 1970. Contract AT(10-1)-1230. 78p. Dep. NTIS.

Results obtained in Test Series CDC-105 of the Spert Subassembly Test Program are presented. The fuel rods used in these tests contained either pellets or powder composed of unirradiated UO_2 and were clad with 0.035-in. wall, 9/16-in. OD, Zircaloy-2 tubing. The rods were fabricated by the same techniques currently used in production of commercial BWR fuel rods. During this test series, diametral swelling of the cladding by as much as 22% was attained by subjecting pellet fuel rods to power bursts which had asymptotic periods between 3 to 5 msec. Investigation revealed that carbon at a concentration level of about 51 ppM in the fuel produced excessive evolution of carbon monoxide. Evolution of gases resulted in internal pressures of sufficient magnitude to produce yielding of the cladding. The source of carbon in the UO_2 was a wax binder used in pressing the fuel pellets. Subsequent tests of fuel rods which contained carbon levels of <1 ppM in the fuel produced little carbon monoxide evolution and only slight swelling of the cladding. The experimental results from dynamic and posttest measurements of the four recently conducted tests are included. The results from all tests in Test Series CDC-105 are also summarized and

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discussed with particular emphasis on diametral swelling of the cladding. (auth)

49571 (JAERI-Memo-4373) STUDY OF IRRADIATION BEHAVIOR OF UO_2 PELLET FOR LIGHT WATER REACTOR. Ichikawa, Michio; Fukai, Katsumaro (Japan Atomic Energy Research Inst., Tokyo). Mar 1971. 25p. (In Japanese). Dep. NTIS (U. S. Sales Only).

High density UO_2 pellets were irradiated in a capsule in the JRR-2 fuel position to investigate irradiation behavior and to develop a capsule irradiation technology. The heat rating was up to 400 W/cm and burnup reached was 200 MWd/t. The irradiation condition was investigated by methods such as activation analyses of monitor wire, temperature measurement in the capsule, gamma scanning, and ceramography. Collected gas from the fuel pin plenum was analyzed by mass spectrometry. Results of post irradiation examination of JPDR test assembly No. 1 are included. (auth) (Japan)

49572 (LA-DC-12563) EFFECTS OF SELF-IRRADIATION ON THE LATTICE OF $^{238(80\%)}PuO_2$. Roof, R. B. Jr. (Los Alamos Scientific Lab., N. Mex.). [1969]. Contract W-7405-eng-36. 11p. (CONF-710802-1). Dep. NTIS.

From twentieth annual conference on applications of x-ray analysis; Denver, Colo. (11 Aug 1971).

As a function of self-irradiation, the crystalline lattice of PuO_2 enriched 80% in ^{238}Pu is gradually altered. The technique of x-ray line broadening was used to search for changes in the crystallite size and strain in the lattice following an initial annealing treatment. The integral breadth, Fourier coefficient, and variance methods were used to analyze the broadening of the x-ray powder pattern lines. The mechanism of alteration appears to be one of retained strain as no evidence was forthcoming from these techniques to indicate that the material undergoes significant crystallite size change. The strain in the lattice increased from zero at time zero to approximately 0.2% during a 2-year period. (auth)

49573 (ORNL-TM-3300, pp 3-52) DEVELOPMENT OF FBR OXIDE FUELS. Patriarca, P.; Lotts, A. L.; Cox, C. M. (Oak Ridge National Lab., Tenn.).

The fabrication and inspection of 20 unencapsulated fuel pins for irradiation in the EBR-II are reported. These pins, which contain sol-gel Sphere-Pac fuel and pellets clad in Type 316 stainless steel, were shipped to the reactor. Twelve fuel pins were fabricated of mechanically blended $(U,Pu)O_2$ pellets. After irradiation in the ETR, these pins will be used for studies of fuel reprocessing. Two encapsulated Sphere-Pac capsules were returned to ORNL after attaining a peak burnup of 6% FIMA at a peak linear heat rate of 14 kW/ft. The peak fluence to which both pins were exposed was approximately 4×10^{22} neutrons/cm^2. The maximum diametral change for one pin, which had Type 304 stainless steel cladding, was 0.0018 in.; the comparable change for another pin, which had Type 316 stainless steel cladding, was 0.0010 in. This difference in diametral expansion seems consistent with measured changes in density due to void formation. Two transverse metallographic sections of the pin with Type 316 stainless steel cladding revealed no evidence of chemical interactions of fuel and cladding even though the temperature of the inner surface of the cladding is calculated to have been 550°C. Further analysis of data from the instrumented tests in the ORR showed that, at least at low burnups, the degree of restructuring, the amount of fission gas released, and the operating temperatures in particulate (Sphere-Pac) and pellet fuels are essentially the same for initial fuel densities of 82% of theoretical. Results of microscopic examination of the Ti-modified Type 304 stainless steel used in one capsule indicated that the cladding exposed to the fuel pellets had undergone localized grain boundary attack to a depth of 0.003 to 0.004 in. during operation to peak temperatures of about 600°C. In an analysis of fuel element performance, special emphasis was given to modeling mechanical interaction of fuel and cladding and to characterizing irradiated $(U,Pu)O_2$ fuels. In support of the modeling effort, a more detailed examination of irradiated microstructures was made to define porosity as a function of radial position, in-reactor redistribution of U and Pu, and migration of fission products in mixed oxide fuels. (J.R.D.)

49574 (ORNL-TM-3300, pp 211-23) DEVELOPMENT OF URANIUM MONONITRIDE FUELS. Patriarca, P.; Scott, J. L. (Oak Ridge National Lab., Tenn.).

In Fuels and materials development program.

Examination of capsule UN-3 after irradiation showed that the T-111 cladding was unsatisfactory for use at a temperature of 1400°C at the outside surface of the cladding. The W-Re cladding performed satisfactorily in the same test at 1300°C. Fabrication of capsules UN-4 and UN-5 is nearing completion. A proposal is being prepared for a program of irradiation testing of UN in the fast-neutron flux of the EBR-II. (auth)

49575 (ORNL-TM-3300, pp 263-5) FAST-NEUTRON IRRADIATION EFFECTS ON ELECTRICAL INSULATORS. Watson, G. M.; Keilholtz, G. W. (Oak Ridge National Lab., Tenn.).

In Fuels and materials development program.

Advanced materials are being evaluated as possible electrical insulators in thermionic converters including: synthetic sapphire Al_2O_3, single-crystal MgO, polycrystalline Y_2O_3, and Si_2ON_2. Preliminary visual inspections of solid cylindrical specimens of these advanced materials that had been irradiated at 400 and 800°C in the EBR-II revealed almost no gross fracture. The results suggest that further investigation of these materials may be warranted as possible alternatives to polycrystalline Al_2O_3, which has the disadvantage of separating at the grain boundaries after receiving moderately high fast-neutron fluences. (auth)

49576 (ORNL-TM-3416, pp 3-51) DEVELOPMENT OF FBR OXIDE FUELS. (Oak Ridge National Lab., Tenn.).

In fuels and materials development program quarterly progress report for period ending March 31, 1971.

Sol-gel-derived $(U,Pu)O_2$ powder for pellets and sol-gel microspheres were prepared for cold dissolution studies. Results of analysis of $(U,Pu)O_2$ reduction in flowing H_2 show that the process is kinetically controlled and is limited by the rate at which H_2O can be removed from the furnace. Ten metallographic sections have been removed from various axial locations along the fuel column of a pin which was irradiated in the EBR-II to a peak burnup of 6% FIMA, a peak linear heat rate of 14 kW/ft, and a peak calculated cladding inner surface temperature of 570°C. No significant fuel-cladding chemical interaction has been observed in any of these sections. Three capsules in this same series that are now at nominally 6 at. % burnup are scheduled for continued irradiation in subassembly X119. The conceptual design of a third EBR-II test series, which is designed to take advantage of the higher flux levels available following the recent EBR-II power increase to 62.5 MW, was completed. The fuel pins will be $(U,Pu)O_2$ using natural U and will be large in diameter to obtain prototypic heat rates and temperatures. To examine the usefulness of the FMODEL fuel performance code in predicting irradiation behavior of LMFBR fuel pins, comparisons have been made between the calculations and measurements on General Electric F2 series of EBR-II irradiation experiments. The comparison was based on cladding diametral expansion, fuel radial porosity distributions and diameters of central void, columnar, and equiaxed grain regions. Overall agreement between predicted and measured fuel pin behavior is acceptable. (J.R.D.)

49577 (ORNL-TM-3416, pp 174-83) DEVELOPMENT OF URANIUM MONONITRIDE FUELS. (Oak Ridge National Lab., Tenn.).

In fuels and materials development program quarterly progress report for period ending March 31, 1971.

Two capsules containing T-111 clad UN fuel elements have been installed in the ORR and are now operating satisfactorily at 1000°C cladding temperature. During startup operation the capsules experienced short-lived temperature perturbations reflecting shifting of the NaK container with respect to the primary vessel. Thermal analysis also revealed a slightly off-center condition of the NaK container with respect to the primary vessel. This caused a lower effective thermal resistance between the fuel elements and the ORR coolant, thus necessitating operation of the fuel elements at a higher heat rating than anticipated to achieve the desired cladding temperature. A third capsule containing T-111 and Nb-1% Zr clad UO_2 fuel elements is being assembled. A plan for testing of refractory metal-clad UN fuel in EBR-II has been prepared and issued as an informal proposal. (auth)

49578 (ORNL-TM-3416, pp 214-15) FAST-NEUTRON IRRADIATION EFFECTS ON ELECTRICAL INSULATORS. (Oak Ridge National Lab., Tenn.).

In fuels and materials development program quarterly progress report for period ending March 31, 1971.

The effects of fast neutrons on four commercial polycrystalline alumina products of high density were investigated. These materials have been considered for use as electrical insulators in nuclear-powered thermionic converters. Results of investigations show that the alumina should be of high purity to minimize gross fracturing, and it should be of small grain size to minimize the effects due to separation at grain boundaries. The thermionic device should be designed for continuous operation because thermal cycling apparently promotes separation at grain boundaries. The design should allow for an increase in volume of the alumina insulators of about 3%. Alumina of high purity and small grain size can withstand fast neutron fluences up to about 3×10^{21} neutrons/cm^2 in an ETR-type neutron spectrum and up to about 2×10^{21} neutrons/cm^2 in an EBR-II-type spectrum for those neutrons with energies greater than 1 MeV. (J.R.D.)

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49579 (ORNL-TM-3416, pp 218-22) DEVELOPMENT OF FUEL ELEMENT FABRICATION. (Oak Ridge National Lab., Tenn.).

In fuels and materials development program quarterly progress report for period ending March 31, 1971.

The irradiation experiment, PM capsule No. 1, is operating satisfactorily in the HFIR. This experiment is designed to evaluate several parameters that are believed to influence the performance of both ATR and HFIR fuel elements at high fission densities. (auth)

49580 (RT/MET-(70)8) RELEASE OF FISSION GAS FROM IRRADIATED UO_2. ANNEALING AFTER IRRADIATION. Lepscky, C.; Podda, G.; Sartori, S.; Tomassi, N. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 26 Aug 1970. 58p. (In Italian). Dep. NTIS (U. S. Sales Only).

During 1968 a series of annealing experiments at temperatures ranging from 1200 up to 2200°C were carried out on irradiated samples of ceramic UO_2 fuel materials. The UO_2 samples were obtained from fuel rods undergoing post-irradiation examination at the hot operations laboratory in Casaccia. It was attempted to give a technological meaning to the work in order to obtain data that could be useful in evaluating the fission gas release during irradiation. The experimental equipment, the techniques, and the results are described and discussed. (auth)

49581 (WAPD-TM-962) FUEL SWELLING MODEL BASED ON CHEMICAL REACTION RATE THEORY AND INCORPORATING RE-SOLUTION EFFECTS (LWBR DEVELOPMENT PROGRAM). Dollins, C. C.; Ocken, H. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jul 1971. Contract AT(11-1)-Gen-14. 18p. Dep. NTIS.

In fuel swelling models based upon the growth of fission gas bubbles the effects due to radiation induced re-solution phenomena are not considered. A fission gas swelling model is described in which it is assumed that fission fragments destroy existing gas bubbles and maintain the resulting gas atoms is supersaturated solid solution. Bubble nucleation and growth continue to take place until another fission fragment passes through the same region. Bubble growth is calculated using reaction rate theory over the period of time in which no radiation damage occurs. The model is used to predict bubble growth significantly smaller than that experimentally determined in UO_2. This discrepancy is attributed to assumptions made in defining the re-solution mechanism. The implication of the model is that fission gas bubble growth is a state function independent of path. If calculations are made within the framework of reaction rate theory using this model, the smallest value for the bubble growth contribution to swelling is found. (auth)

49582 TESTING OF REACTOR FUEL ELEMENTS AND MATERIALS UNDER IRRADIATION. Bull. Inform. Sci. Tech. (Paris); No. 153-154, 75-82(Nov-Dec 1970). (In French).

Tests were effected on materials and fuel element assemblies. A degradation in the mechanical properties of the materials under irradiation was observed, which causes hardening of the samples, and their embrittlement or swelling. Neutrons produce embrittlement, deformation, and corrosion in the fuel element assemblies. The thermal effect produced creates temperature variations between the clad surface, the fuel surface, and the core. Some examples of testing under irradiation are given. (France)

49583 IRRADIATION DEVICES USED FOR THE STUDY OF NUCLEAR FUELS OF FAST NEUTRON REACTORS. Bull. Inform. Sci. Tech. (Paris); No. 153-154, 111-7(Nov-Dec 1970). (In French).

In the irradiation devices used for the study of fast neutron effects on reactor fuel elements, the irradiated fuel element is in a sodium or NaK bath, the enclosures being stainless steel tubes. The experiments described took place at Osiris and Siloe. The Odile device, which is the more classical, was designed to irradiate oxides. The Heloise device, which may extract very high power, has no regulating controls and may be used with carbide-type fuel elements. The Esther device simulates the axial temperature distribution of a fast reactor. A very satisfactory reliability was obtained. (France)

49584 AMORPHIZATION OF A Pd-Si ALLOY BY IRRADIATION WITH FISSION PRODUCTS. Lesueur, D. (CEN, Fontenay-aux-Roses, France). Fizika (Zagreb); 2: Suppl. 2, 13.1-8(1970).

From International conference on metastable metallic alloys; Brela, Yugoslavia (28 Sep 1970). See CONF-700952.

The irradiation of a Pd-20 at. % Si alloy by heavy ions induces amorphization. It is suggested that the displacement spikes are responsible for this amorphization. Further experiments are now going on to test this hypothesis and, more precisely, to separate the apparently competing influences of the thermal and of the displacement spikes. (auth)

49585 STRUCTURE OF REACTOR GRAPHITES AND ITS RELATION TO HIGH TEMPERATURE IRRADIATION DIMENSIONAL STABILITY. Thrower, P. A. (Atomic Energy Research Establishment, Harwell, Eng.). Carbon; 9: No. 3, 265-77(May 1971).

The structures of six reactor graphites, for which high-temperature dimensional change data are available, were examined by a variety of techriques. Four distinctly different types of particles were observed. The nucleation of the irradiation-induced defects in the various types of particles identified was observed by transmission electron microscopy wherever possible. The observations on irradiated material are explained by a model of defect nucleation involving separation of vacancies and interstitials at high temperatures by the latter diffusing along non-basal defects. This model suggests a correlation between crystalline perfection and dimensional changes at 900°C which appear to be borne out by the data. The role of boron in the nucleation of defects at high irradiation temperatures is discussed and a possible beneficial effect is suggested. (auth) (UK)

49586 IRRADIATION-INDUCED DIMENSIONAL CHANGES IN IMPERFECT GRAPHITE CRYSTALS. Bokros, J. C.; Guthrie, G. L.; Stevens, D. W. (Gulf General Atomic Co. San Diego, Calif.). Carbon; 9: No. 3, 349-53(May 1971).

Length and volume changes were determined at 850 to 1300°C, as a function of fast fluence (E > 0.18 MeV) for natural graphite crystals and for annealed pyrolytic material. At approximately 900°C there was no significant difference in the behaviour of the materials, but at 1200° to 1300°C linear changes for natural crystals were an order of magnitude smaller than for annealed material. At low fluences the rates of c-axis growth for natural graphite were consistent with values predicted from direct observations of size and distribution of irradiated interstitial loops, but at higher fluences, especially about 1200°C, c-axis growth rates were higher and were accompanied by a volume increase. (UK)

49587 KINETICS OF RELEASE OF FISSION FRAGMENTS FROM CERAMIC FUELS. Samsonov, B. V.; Frei, A. K. At. Energ. (USSR); 30: No. 4, 358-62(Apr 1971). (In Russian).

The SM-2 reactor was used to study the release of gaseous fission products from ceramic fuels in order to determine the apparent diffusion coefficient of UC, UC_2, and UO_2-type fuels. The test specimens were loaded into stainless steel tubes which were irradiated in the beam hole. The fission fragments were carried away by a helium stream past γ, β, and n-counters and a trap for short-lived fragments. Results of the analysis revealed that the iodine isotopes are completely adsorbed on the tubing. The diffusion coefficient of these isotopes was determined on the basis of the ^{133}Xe and ^{135}Xe formed in the system together with the ^{138}Xe formed in the trap. The results revealed the diffusion of the gaseous fission fragments at doses from $\sim 2 \times 10^{16}$ fissions/cm^3 and higher, decreases and assumes a steady-state character at a dose of 5×10^{18} to 5×10^{19}. The decrease is uneven for various isotopes; it was largest, $\sim 10^4$ to 10^6 fold for ^{133}Xe; 10^2 to 10^3 for ^{135}Xe and only 5 to 20 fold for ^{138}Xe. The reduction may be ascribed to capture by the internal pores which formed voids as a result of irradiation of the ceramic material. The experimentally and theoretically determined test conditions of UO_2 and UC_2 agreed satisfactorily; in case of the monocarbide, the difference exceeded the experimental error. (TTT)

Plastics and Other Materials

Refer also to abstracts 48706, 48713, 48715, 49848, and 49984.

49588 (MLM-1802) METHODS AND MATERIALS FOR ENCAPSULATION: A LITERATURE SURVEY. Bump, D. D. (Mound Lab., Miamisburg, Ohio). 2 Aug 1971. Contract AT(33-1)-Gen-53. 34p. Dep. NTIS.

Five processes are used for encapsulation—conformal coating, casting, potting, transfer molding, and impregnation. The materials most used are the epoxies, accounting for about 85% of the applications. Other common materials are silicones, polyurethanes, polyesters, thermosetting hydrocarbons, thermosetting acrylics, and polysulfide resins. The industrial literature provides the best guide for selection of encapsulation materials once the basic type is selected. (auth)

49589 (N-71-20402) EXPERIMENTAL IN SITU INVESTIGATION OF THE EFFECTS OF PROTONS, ULTRAVIOLET RADIA-

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TION, AND TEMPERATURE ON THERMOPHYSICAL PROPERTIES OF SOLAR CELL FILTERS AND OTHER SPACECRAFT MATERIALS. Fogdall, Lawrence B.; Cannaday, Sheridan S. (Boeing Co., Seattle, Wash. Research and Engineering Div.). Feb 1971. Contract NAS7-100. 142p. (NASA-CR-117365). NTIS.

An investigation was conducted to determine in situ the effects of ultraviolet radiation and solar-wind protons on materials considered for use on the 1973 Venus–Mercury flyby vehicle. The experimental program involved more than 2400 hours of continuous radiation-facility testing, preceded, interrupted, and followed by in situ thermophysical property measurements on transmissive solar-cell filters, opaque solar-cell-filter stacks, adhesives, 7940 fused silica, and Kapton film. Sun rate, solar wind rate, and sample temperature were all increased with time during the 2400 hours, providing an accurate simulation of radiation conditions along the planned flyby trajectory. Final exposure levels of 12,000 ESH and 10^{16} protons/cm^2 were reached. Solar absorptance increased and solar transmittance decreased in most solar-cell filters. The solar absorptance of solar-cell-filter stacks also increased. Changes measured in solar-cell filters were generally less than changes measured on solar-cell-filter stacks. Both ultraviolet and proton exposure reduced the effectiveness of the ultraviolet-rejection coatings in the solar-cell filters. In some materials, simultaneous exposure to protons and ultraviolet radiation yielded synergistic damage greater than the sum of proton degradation and ultraviolet degradation in separate samples. Thermal damage in unbonded Kapton film was catastrophically large. (auth) (STAR)

49590 STUDY OF TEMPERATURE AND RADIATION ENDURANCE OF MATERIALS. Fallou, Brigitte; Belloc, Pierre (Laboratoire Central des Industries Electriques, Fontenay-aux-Roses, France). Rev. Gen. Elec.; 80, No. 3, 217-4(Mar 1971). (In French).

A study of the endurance strength of insulating materials with respect to long duration stresses resulting from temperature and high energy radiation effects is described. The idea of a temperature index is clearly defined with respect to thermal endurance as are all the associated statistical problems. The consideration of the special case of insulating varnishes indicates the difficulties encountered in determining these indices and leads to examples of their uses. The effects of high energy radiation on materials are examined from two points of view: maximum admissible doses from which the radiation index may be determined and the principal factors modifying its behavior such as dose rate, ambient atmosphere and material thickness. Particular attention is given to the effect of transient radiation on the electrical characteristics of insulating materials, and especially to the currents induced under these conditions. (France)

49591 THERMAL INSULATION. Milner, Malcolm John (to British Nuclear Design and Construction Ltd.). British Patent 1,233,537. 26 May 1971. Filed 25 May 1967.

A form of thermal insulation is described that is suitable, among other applications, for the internal surface of a gas-cooled nuclear reactor concrete pressure vessel. It consists of a batt of refractory fibres enclosed with cloth woven from refractory fibres enclosed with cloth woven from refractory fibres. A number of holes pass through the covered batt, each hole being lined with a sleeve of the same cloth. The fibres preferably are of silica, alumino-silicate, glass, asbestos, or slag wool. The insulation layer should be of optimum bulk density, just sufficient to suppress local thermal convection for the specific fibre and specific environmental gas conditions. The fibres should have a diameter within the range 1 to 5 μ, compressed to give a bulk density within the range 3 to 15 lb/ft^3. Several of such insulating layers may be provided. (UK)

49592 THERMODYNAMICS OF ION EXCHANGE ON NIOBIC HYDROXIDE. Sukharev, Yu. I.; Egorov, Yu. V. (Siberian Metallurgical Inst., Stalinsk, USSR). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 2, 238-42(Feb 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 2, 270-4(Feb 1971).

An equation was derived which represents the nature of change in apparent equilibrium coefficients of bichromate ions with the degree of coverage of niobic hydroxide specimens by chromium. It is shown that calculation of the thermodynamic equilibrium constants of bichromate ions and the activity coefficients of OH^- and $Cr_2O_7^{2-}$ ions in the solid phase by the Hoegfeldt and Tolmachev methods gives practically the same values. Results of calculations show that treatment of niobic hydroxide with ferrocyanide ions produces a structural change in the nature of the exchange centers, which leads to a regular change in the entropy of exchange systems with niobic hydroxide. (auth)

49593 RESISTANCE DETERMINATION OF EXPLOSIVES AND PROPELLANTS TO GAMMA RAYS. Piantanida, E.; Piazzi, M. (Accademia Navale, Livorno, Italy). Chim. Ind. (Milan); 53: 3p (Jan 1971). (In Italian).

The resistance of explosives and propellants to γ rays was measured with thermomanometric methods at temperatures at which these substances usually begin to decompose. Since the resistance measurement followed on the decomposition isotherm is altered by the complex autocatalytic reactions, the criterion was adopted of following the resistance measurement of the resistance isotherm in which the end of the induction period for the decomposition reaction occurs. The induction times of typical explosives and propellants were measured before and after irradiation. The criterion adopted makes possible a greater precision and sensitivity of the heat resistance measurement. (tr-auth)

49594 INFLUENCE OF NEUTRON RADIATION ON THE PROPERTIES OF CHROMITE CONCRETE. Dubrovskii, V. B.; Korenevskii, V. V.; Pergamenshchik, B. K.; Perevalov, V. S. Energ. Stroit.; No. 9, 65-7(Sep 1970). (In Russian).

Results of investigations of the properties of chromite concrete and its components recommended for construction of the radiation-thermal shielding of nuclear power plants are discussed. (INIS)

49595 CHANGE IN THE PROPERTIES OF CONCRETE AGGREGATES UNDER THE ACTION OF NEUTRON RADIATION. Dubrovskii, V. B.; Pergamenshchik, B. K.; Korenevskii, V. V.; Perevalov, V. S. Beton Zhelezobeton; 16: No. 9, 25-7(1970). (In Russian).

Limestone and chromite are not equally damaged by exposures to 2.8×10^2 n/cm^2 and 7.8×10^{20} n/cm^2. Limestone is recommended for use in concrete shielding exposed to doses up to 2.8×10^{20} n/cm^2 and chromite for doses up to 7×10^{20} n/cm^2. Granite, sandstone, basalt, hematite, and fire clay are damaged, showing volume increase of 0.1 to 0.2% after exposure to doses of 1 to 5×10^{19} n/cm^2. Granite expands most, reaching 6.5% volume increase after exposure to doses of 2.4×10^{20} n/cm^2. Expansion rates are usually reduced by increase in irradiation temperature. The expansion of mixes occurs as a result of individual mineral expansion during irradiation because of separation in the polymixtures. Maximum radiation doses for concretes containing granite, sandstone, hematite, basalt, or fire clay can be determined after evaluation of coarseness, and the effects of filler material expansion on concrete properties. (tr-auth)

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PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstract 50180.

49596 (AD-715925) STUDY OF SOME ASTROPHYSICAL PROBLEMS CONCERNING PLASMA PROCESSES AND ROTATIONAL HYDRODYNAMICS. Final Report, February 15, 1969–August 31, 1970. Frey, John H.; Yukon, Stanford P. (Sea Farm Research Foundation, Inc., Waltham, Mass.). 30 Sep 1970. Contract F19628-69-C-0215. 66p. (AFCRL-70-532). NTIS.

Synchrotron and Cherenkov radiation below the plasma frequency from particles spiraling in a magnetoplasma were investigated. Both the longitudinal and transverse emissivity were calculated for mildly relativistic particles with particular attention being given to radiation from resonance regions. A new and stronger inequality for the density dependence at fixed entropy of the equilibrium energy of an arbitrary collection of point particles interacting with Coulomb (inverse power law) forces was derived. Calculations based upon this derivation are necessary for models of the heavy planets as well as for models of stellar structure. A dynamo mechanism for solar flare energy production at photospheric heights was investigated. A set of equations for the motions of ions and electrons located just above the photosphere was obtained, which facilitates the derivation of quantitative results. The problem of two-dimensional hydrodynamics with rotation, i.e., Rossby waves in a rotating disc of incompressible fluid, was examined. (auth) (USGRDR)

49597 (CONF-690732, pp 8,1-37) PLANETO-, ASTRO-, GALACTO-, AND COSMO-PHYSICS. Engelbrecht, C. A. (Atomic Energy Board, Pretoria (South Africa)).

From 4. seminar on theoretical physics; Johannesburg, South Africa (7 Jul 1969).

Attention is directed to some of the recent and interesting developments in the study of the planets and solar system, stars, galaxies and the universe, and quasars, pulsars, and gravitational collapse. (W.D.M.)

Stars

Refer also to abstracts 49768 and 49815.

49598 METHOD FOR INCREASING THE DYNAMIC RESPONSE OF PHOTOMETRIC SYSTEMS. Lee, Paul; Perry, Charles L. (Louisiana State Univ., Baton Rouge). Astron. J.; 76: No. 7, 619-20(Sep 1971).

The effects of a neutral-density attenuator on the measured magnitudes and colors of stars are discussed. Such a scheme offers a way of measuring bright stars with a pulse-counting system. (auth)

49599 FOUR-COLOR AND Hβ PHOTOMETRY FOR BRIGHT B-TYPE STARS IN THE SOUTHERN HEMISPHERE. Crawford, D. L.; Barnes, J. V.; Golson, J. C. (Kitt Peak National Observatory, Tucson, Ariz.). Astron. J.; 76: No. 7, 621-30(Sep 1971).

Photoelectric photometry is presented for 325 B-type stars south of declination −10° and with 5.0m < m_V < 6.5m. (auth)

49600 PHOTOMETRIC VARIABILITY OF THE Be STAR θ CORONA BOREALIS. Roark, T. P. (Ohio State Univ., Columbus. Ohio Wesleyan Univ., Columbus). Astron. J.; 76: No. 7, 634-8 (Sep 1971).

Four-color uvby and Hα filter observations were made of the Be star θ CrB in June and September 1970. Photometric variations as large as 0.7 mag in the u and v bands were observed in June. There appear to have been no spectroscopic changes accompanying this light variation. The variability is interpreted in terms of particulate matter in the atmosphere of the star. The size distribution of the particles must change rapidly with time to explain the detailed structure of the light curves in a single night and from night to night. (auth)

49601 PHOTOELECTRIC OBSERVATIONS OF MAGNETIC STARS. III. HD 124224, HD 140160, AND HD 224801. Blanco, C.; Catalano, F. A. (Univ., Catania, Italy). Astron. J.; 76: No. 7, 630-3(Sep 1971).

Photoelectric observations in three colors of the magnetic stars HD 124224, HD 140160, and HD 224801 are reported. An improved period is given for HD 224801. For all three stars the oblique rotator model seems to be reliable. (auth)

49602 PHOTOMETRIC STUDY OF THE GALACTIC CLUSTER NGC 5460. Claria, J. J. (Univ. Nacional, Cordoba, Argentina). Astron. J.; 76: No. 7, 639-44(Sep 1971).

Three-color photoelectric photometry was carried out for 64 stars in the vicinity of the southern galactic cluster NGC 5460. Hβ photometry for 16 stars is also presented. The stars range in V magnitude from 6.49 to 13.07m. Analyses of UBV data confirmed that NGC 5460, with a minimum membership of 37 stars, is reddened by 0.14m and is located at a distance of 780 pc. Independent analyses of UBV and Hβ data showed that the absolute magnitude calibrations and intrinsic color relations derived from both UBV and Hβ photometry are in very good agreement. An age of 4×10^7 yr was obtained for the cluster. (auth)

49603 WAVELENGTH DEPENDENCE OF POLARIZATION. XXII. OBSERVATIONS OF NOVAE. Zellner, Ben (Univ. of Arizona, Tucson); Morrison, Nancy D. Astron. J.; 76: No. 7, 645-50(Sep 1971).

Extensive observations of HR Delphini (Nova Delphini 1967) showed the polarization to be variable by at least 1.2% at intermediate wavelengths but almost constant in the ultraviolet and infrared. An evaluation of the interstellar component led to the following conclusions: During the first 120 days after outburst, the intrinsic polarization was sharply peaked over wavelength with a maximum averaging 0.6% in red light. In the later stages, the intrinsic component was generally small and irregularly variable with no systematic wavelength dependence. Nova Serpentis 1970 also fluctuated in polarization by more than 1%, but no polarization variability was detected for Nova Vulpeculae No. 1 1968. (auth)

49604 WAVELENGTH DEPENDENCE OF POLARIZATION. XXIII. DUST GRAINS IN NOVAE. Zellner, Ben (Univ. of Arizona, Tucson). Astron. J.; 76: No. 7, 651-4(Sep 1971).

The Mie theory for spherical dust grains was used to compute the polarizations produced by circumstellar dust clouds of low optical depth. While the detailed computations were for clouds in the form of ellipsoids of revolution, the results are not strongly dependent upon cloud shape. Polarization observations during the early stages of Nova HR Delphini 1967 can be explained by grains of iron or graphite, but not by pure silicates. The grain radius was near 0.10 μ, the optical depth in visible light about 0.25, and the total mass in the form of dust was approximately 10^{-9} $M_\odot$. It is proposed that the 0.10-μ grains served as condensation nuclei for the later formation of large particles in a much more massive cloud, giving rise to a strong thermal infrared excess and weak polarizations. (auth)

49605 EFFECT OF BETA PROCESSES ON THE DYNAMIC EVOLUTION OF CARBON-DETONATION SUPERNOVAE. Bruenn, Stephen W. (Florida Atlantic Univ., Boca Raton. New Mexico Inst. of Mining and Tech., Socorro). Astrophys. J.; 168: No. 2, 203-15(1 Sep 1971).

The effect of β processes on the detonation and postdetonation evolution of a degenerate carbon–oxygen core which explosively ignites $^{12}C + {}^{12}C$ at $\rho = 2 \times 10^9$ g cm^{-3} was studied by numerical hydrodynamic calculations. It was found that β processes, even when increased by a factor of 3, have no qualitative and only minor quantitative effects on the postdetonation evolution. Some preliminary results for nucleosynthesis are discussed. (auth)

49606 LATE EVOLUTION OF CLOSE BINARIES. Vila, Samuel C. (Univ. of Pennsylvania, Philadelphia). Astrophys. J.; 168: No. 2, 217-23(1 Sep 1971).

The evolution of binaries whose primary is a white dwarf and whose secondary is a star with mass less than 0.1 $M_\odot$ that fills its critical lobe was calculated, with account taken of the loss of angular momentum by gravitational radiation given by Einstein's gravitational theory. The stars were assumed to possess no nuclear-energy sources and simply to be radiating their internal energies. The loss of angular momentum results in a transfer of mass from the secondary to the primary that causes the period and the separation of the stars to increase with time. The mass of the secondary tends asymptotically to zero with increasing time. (auth)

49607 CONJECTURE CONCERNING THE TRANSITION PERIOD FOR VARIABLE STARS. Iben, Icko Jr. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 168: No. 2, 225-30(1 Sep 1971).

It is conjectured that a helium-sensitive relationship between period and luminosity that is obtained with linear theory is closely

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related to a transition curve obtained with nonlinear theory. It follows that the luminosity inferred for RR Lyrae stars in populous clusters by using the transition curve may be a function of the assumed helium abundance. (auth)

49608 OSCILLATIONS AND THE STABILITY OF ROTATING MASSES WITH TOROIDAL MAGNETIC FIELDS. II. **Kochhar, R. K. (Panjab Univ., Chandigarh, India); Trehan, S. K. Astrophys. J.: 168: No. 2, 265-80(1 Sep 1971).**

The oscillations and the stability of rotating gaseous masses with prevalent toroidal magnetic fields were examined by using the second-order tensor virial equations. It is shown that in the presence of rotation (solid body and differential) and toroidal magnetic field the point of bifurcation, where the Jacobi ellipsoids branch off from the Maclaurin spheroids, is unaffected by the presence of the magnetic field and differential rotation. The presence of the magnetic field increases the critical value of the eccentricity, where the Maclaurin spheroids become unstable, above the value e = 0.9529 that obtains in the absence of a magnetic field. In the equipartition state it is the radial mode which becomes unstable for $\gamma \leq 6/5$ whereas for $\gamma > 6/5$ it is the Kelvin mode which becomes unstable. The solid-body rotation has a stabilizing influence on both these modes. The frequencies of the transverse shear modes, the toroidal modes, and the pulsation modes are tabulated for M/|W| (the ratio of the magnetic to the gravitational energies) = 0.05, 0.15, and 0.30 and for γ = 1.3, 4/3, 1.4, 1.5, 1.6, and 5/3. (auth)

49609 RADIATIVE RECOMBINATION COEFFICIENTS FOR COMPLEX IONS. **Tarter, C. Bruce (Univ. of California, Livermore). Astrophys. J.: 168: No. 2, 313-16(1 Sep 1971).**

Radiative recombination coefficients were calculated for complex ions of astrophysical interest. A least-squares procedure was used to obtain three-term parametric expressions that agreed with the computed values to better than 3% over the temperature ranges of interest. (auth)

49610 RATE OF THE $^{12}C + ^{16}O$ REACTION. **Hansen, Carl J.; Zaidins, Clyde S. (Univ. of Colorado, Boulder). Astrophys. J.: 168: No. 2, 317-18(1 Sep 1971).**

The rate of the $^{12}C + ^{16}O$ reaction was calculated to within a factor of 2 from new experimental data. It is shown that its contribution to energy generation is negligible compared with $^{12}C + ^{12}C$ under normal circumstances, though it may have some effects on nucleosynthesis. (auth)

49611 OBSERVATIONS OF STELLAR CHROMOSPHERES. **Zirin, H. (California Inst. of Tech., Pasadena). Phil. Trans. Roy. Soc. London, Ser. A: 270: No. 1202, 183-8(1971).**

The number of stars for which a flash spectrum is observable is very limited, and in order to study stellar chromospheres only the integrated stellar spectrum can be used. This limits observations to a few lines which satisfy the two conditions that they must have a reasonable optical depth in the chromosphere and that they must show different behavior in the chromosphere than in the photosphere. In the visual region only three lines satisfy these conditions: the H and K lines of Ca II and the 1083-nm line of metastable He. The former appear as doubly reversed emission lines, and this emission must come uniquely from the chromosphere. The 1083-nm line does not have a great optical depth, but its excitation temperature is so high that it could only appear at temperatures higher than that of the photospheres of most late-type stars. The Hα line is a more complicated case, but it almost certainly comes from the chromosphere, but the chromospheric effects are not so well marked, except in M stars and other red stars, where it may appear in emission. Chromospheric effects have also been occasionally observed in the D3 line and in other H lines that also appear in emission. It is emphasized that chromospheric activity can never be detected in Sun-like stars, except in the euv, the extensive studies of the K line and the 1083-nm line were only possible on account of an activity level far exceeding that in the Sun. Observations of the H and K lines and of the 1083-nm line are described in detail, and consideration is given to M stars, CN bands, and changes with time. (UK)

49612 OAO (ORBITING ASTRONOMICAL OBSERVATORY) OBSERVATIONS OF Mg II EMISSION IN LATE-TYPE STARS. **Doherty, L. R. (Univ. of Wisconsin, Madison). Phil. Trans. Roy. Soc. London, Ser. A: 270: No. 1202, 189-95(1971).**

It is stated that since spectral features in cool stars are most sensitive to temperature differences in the uv, observations of uv spectra should yield considerable information concerning the nature of chromospheric structure in stars. Recently the OAO-2 has scanned a number of bright stars of spectral type G, and in the region 180 to 370 nm, with a resolution of about 2.5 nm. Some of the characteristics of these low resolution spectra are discussed, with particular emphasis on the appearance of the 280 nm Mg II doublet. The spectra were recorded with an objective-grating spectrometer, with a collecting area of 265 cm^2. Excellent agreement was found between the spectral features of α Cen and the Sun, and normal G8 giants closely resembled the Sun. Mg II appeared as a deep single absorption feature. Tabulations are presented of the stars observed, with their V magnitudes and spectral types, together with data for selected scans of three of the brightest stars (α Boo, α Tau and α Ori). Below 285 nm the only identifiable feature in the spectrum of α Boo is strong Mg II emission, and Mg II emission is also strong in α Tau and α Ori, with no clear evidence of other spectral features below ~310 nm. In general, the shorter the wavelength the more rapidly the flux decreased with advancing spectral type, but this trend was reversed with α Tau. It appears from the limited data available that transition from Mg II absorption to emission at 2.5 nm resolution occurs at K2 for both giants and supergiants. It also appears that the circumstances of formation of the emission in the H and K lines of Ca II and Mg II must be similar, and the data for Mg II and Ca II are compared for the observed stars. (UK)

49613 CONFERENCE ON COORDINATION OF OBSERVING TECHNIQUES OF VISUAL DOUBLE STARS, NICE, FRANCE, SEPTEMBER 8–10, 1969. **Heintz, W. D. (ed.). Astrophys. Space Sci.; 11: No. 1, 1-188(Apr 1971). (In French and English). (CONF-690982).**

The conference, dedicated to William H. van den Bos was organized into six sessions. The discussions at the end of each paper are abridged and summarized to some extent. (W.D.M.)

49614 SPECTROPHOTOMETRIC STUDY OF THE CONTINUOUS SPECTRUM OF THE ECLIPSING DOUBLE STAR AW PEG. **Babaev, M. B. (Shemakha Astrophysical Observatory, USSR). Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Tekh. Mat. Nauk; No. 4, 109-15(1970). (In Russian).**

Spectral observations were conducted of the eclipsing variable AW Peg during the summers of 1967 and 1968. The spectrophotometric gradient and temperature of this system varied noticeably with the phase of the brightness. The primary and secondary components of the system AW Peg are of the spectral classes A0V and F5IV, respectively. The primary component has an extended shell. (K.S.W.)

49615 NEUTRON-STAR MODELS AND NUCLEAR FORCES. **Hillebrandt, W.; Kistler, S. (Univ., Cologne). Z. Phys.; 246: No. 1, 60-70(1971).**

Equations of state of cold neutron matter are calculated by the method of unitary transformations for a hard-core and a soft-core potential. Equilibrium configurations are constructed in the Newtonian and the general relativistic theory of gravitation. It is found that Newtonian treatment to a certain extent gives very good results. On the other hand, neutron star models are strongly affected by the nuclear forces used in the equation of state. (auth)

49616 MAGNETIC CAPTURE DURING ACCRETION. I. **Amnuel, P. R.; Guseinov, O. Kh. (Shemakha Astrophysical Observatory, USSR). Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Tekh. Mat. Nauk; No. 5, 74-82(1970). (In Russian).**

In observing neutron stars or white dwarfs the accretion of interstellar gas may be witnessed, and the presence of a strong magnetic field may lead to various effects: (1) during symmetric accretion frontal capture occurs, exciting radiofrequency emission (apparently more probable than uv or x radiation), or (2) during asymmetric accretion an abrupt increase in the speed of accretion occurs. In this case, observation of radiation is poor since the frontal capture takes place at great distances from the star. (K.S.W.)

49617 TWO POSSIBLE COURSES OF EVOLUTION OF WOLF–RAYET STARS. **Gusein-Zade, A. A. (Shemakha Astrophysical Observatory, USSR). Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Tekh. Mat. Nauk; No. 5, 83-6(1970). (In Russian).**

Wolf–Rayet stars are situated in the upper region of the Hertzsprung–Russel diagram, to the left of the main sequence, and may be formed from stars of spectral type O. From the discussion given of the possible courses of evolution, it is concluded that Wolf–Rayet stars evolve by mixing of matter from the interior into the outer layers, moving to the left from the main sequence. The products of nuclear reactions would then be observable, giving rise to anomalies in the chemical composition of their atmosphere. In double stars, if one of the components is a Wolf–Rayet type, it should be possible to observe an anomaly of the spectral type O. On the other hand, Wolf–Rayet stars may not be formed independently at the beginning of evolution, but instead are formed from other stars. (K.S.W.)

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Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstracts 48930 and 48931.

49618 (AD–714110) QUASAR MODELS AND NEBULAE. Final Report, July 1, 1967–September 30, 1970. Gold, Thomas (Cornell Univ., Ithaca, N. Y. Center for Radiophysics and Space Research). Oct 1970. Contract N00014-67-A-0077-0007. 13p. (CRSR–406). NTIS.

Work done on quasars, radio galaxies, pulsars, and the background microwave radiation is summarized. Theories and interesting observations are offered in reference to these topics. A bibliography follows the text. (USGRDR)

49619 (AD–714824) OBSERVATIONS OF THE OWENS VALLEY RADIO OBSERVATORY. 10. DUAL-FREQUENCY ORTHOGONAL STRIP DISTRIBUTIONS OF LINEARLY POLARIZED AND TOTAL RADIATION IN EIGHT EXTRAGALACTIC RADIO SOURCES. Seielstad, G. A.; Weiler, K. W. (Owens Valley Radio Observatory, Pasadena, Calif.). 1970. Contract N00014-67-A-0094-0008. 46p. NTIS.

One-dimensional distributions of the total and linearly polarized radiation from 3C 227, 3C 270, 3C 278 Cen A (central), 3C 327, Ier A, 3C 353, and 3C 403 were obtained at frequencies of 1420 and 2880 MHz. Both right-ascension and declination scans are presented. Distributions of depolarization, rotation measure, and intrinsic polarization angle were calculated. Variations of spectral index within sources were noted. The magnetic field near the center of many radio galaxies is perpendicular to the major axis; in the outer components it is either approximately perpendicular or parallel. Correlations were found between rotation measure and depolarization rate in some cases. (auth) (USGRDR)

49620 (AD–716492) STUDY OF COSMIC GAMMA RADIATION. Final Technical Report, February 1, 1967–August 31, 1970. Greisen, Kenneth I. (Cornell Univ., Ithaca, N. Y. Lab. of Nuclear Studies). 30 Sep 1970. 17p. (AFOSR–70–2466–TR). NTIS.

Research summarized consists of two main components: balloon flights of a large spark chamber in search of discrete sources of gamma rays with energy above 700 MeV; and development of a very large gamma-ray telescope, 4.6 m^2 in sensitive area, utilizing Cherenkov radiation in a low-pressure gas to detect gamma rays above 150 MeV with good angular resolution and excellent background rejection. The spark chamber flights detected no sources yielding more than 0.000005 gammas/cm^2 sec. An apparent source of about this strength, close to the location of M87, may be a statistical fluctuation. Properties of the Cherenkov telescope and its behavior in sea level tests are summarized, but flights of the instrument were not carried out. (auth) (USGRDR)

49621 (AD–716800) SPIN-EXCHANGE SCATTERING. Final Report, December 1, 1963–November 30, 1969. Glassgold, A. E. (New York Univ., N. Y.). 30 Nov 1969. Contract Nonr-285(58). 6p. NTIS.

During the first six years of this contract, the research program became progressively broader. The original thrust of the research was directed toward the quantum-mechanical description of spin-exchange scattering and its role in understanding the forces between paramagnetic atoms. This naturally led to the study of other atomic collision problems, e.g., electron–hydrogen scattering, and to consideration of collections of atoms in the gaseous state. From there it was natural to also study collisions in the plasma state and applications to astrophysics. Finally, in light of possibly the most important recent discovery in astrophysics, the pulsars, the latest research carried out under this program has dealt with the theory of neutron stars. (auth) (USGRDR)

49622 (AD–717665) OPTICAL AND RADIO INVESTIGATIONS OF SOURCES OF COSMIC X RAYS. Final Report. Johnson, Hugh M. (Lockheed Missiles and Space Co., Palo Alto, Calif.). 31 Dec 1969. Contract N00014-69-C-0147. 5p. NTIS.

The work of 1969 was based primarily on four trips to observatories, where the observations were made as a guest investigator. The 36- and 60-inch CTIO reflectors were used for photoelectric photometry with a special set of narrow-band filters on some identified x-ray sources and on what the author refers to as their "analogues"—objects with optical peculiarities that somewhat resemble those of x-ray sources and so may shed light on them. The 50- and 16-inch KPNO reflectors were used with instrumentation practically identical to that at CTIO on T CrB, CH Cyg, Cyg X-2, and the field of nebulae within 18° of Sco X-1. A new attack on the problem of the effect of interstellar absorption on the observed x radiation of Sco X-1, and the inverse problem of the effect of the radiation of Sco X-1 on interstellar matter, was the object of a 21-cm study of neutral hydrogen in the field of Sco X-1. The 48-inch Palomar Schmidt telescope was used with a special pair of filters that pass λ4686. (USGRDR)

49623 (AD–717668) SEARCH FOR POLARIZATION IN THE X-RAY EMISSION OF THE CRAB NEBULA. Wolff, R. S.; Angel, J. R. P.; Novick, R.; Vanden Bout, P. (Columbia Univ., New York. Columbia Astrophysics Lab.). Dec 1969. Contracts N00014-67-A-0108-0017; NAS8-24688. 16p. (CAL-Contrib–13). NTIS.

The results can best be interpreted as setting an upper limit of 27% on the polarization of the x-ray emission of Taurus X-1 with a 99% confidence level. The present result does not serve to distinguish between synchrotron and other processes suggested for x-ray production in the Crab Nebula. (auth) (USGRDR)

49624 (AD–722871) MAGNETIC FIELDS IN STARS AND GALAXIES: RADIATION PROCESSES AND INTERACTION WITH IONIZED MATERIAL IN MAGNETIC FIELDS. Final Report, February 1, 1964–January 31, 1971. Woltjer, L. (Columbia Univ., New York. Dept. of Astronomy). Apr 1971. Contract AF49(638)-1358. 14p. (AFOSR-TR–71-1100). NTIS.

The report covers research from 1964 to 1971. Results are listed and discussed, including magnetic fields in stars and stellar evolution of white-dwarf and neutron stars, magnetic fields and gas flows in galaxies, supernova remnants, quasars, x-ray sources, and cosmic rays. Publications are listed. (auth) (USGRDR)

49625 (N–71–23855) NEW X-RAY STAR. (National Aeronautics and Space Administration, Washington, D. C.). 31 Mar 1971. 6p. (NASA-News-Release–71–50). NASA.

A pulsating x-ray star quite unlike the one other known x-ray pulsar was detected in the Milky Way by Explorer 42, the Small Astronomy Satellite, launched last Dec. 12. The newly detected x-ray pulsar, 13 new x-ray objects found both within the Milky Way and several remote galaxies, and confirmation that a distant quasar is a source of powerful x rays, are included in the initial scientific results from Explorer 42. The x-ray pulsar, identified as Cygnus X-1 in the Constellation Cygnus, was observed by the satellite to generate precisely timed x-ray pulses at the rate of about 15 per second. (auth) (STAR)

49626 UPPER LIMITS TO THE MASSES OF SOME QSOs. Evans, A.; Falla, D. F. (University Coll. of Wales, Aberystwyth). Nature (London) Phys. Sci.; 232: No. 29, 57-8(19 Jul 1971).

It is shown that it is possible in some cases to set upper limits to QSO masses that are independent of redshift, and the method described is also independent of detailed physical models for QSOs. Data are given for 3C 273B, 3C 147B, 4C 39.25B, and CTA 102. (UK)

49627 RAPID OPTICAL VARIABILITY OF SOURCE PKS 1514-24. Biraud, F. (National Radio Astronomy Observatory, Green Bank, W. Va.). Nature (London); 232: No. 5307, 178-9 (16 Jul 1971).

Reference is made to cases in which radio sources have been identified with optical objects previously known as variable stars, of which two instances were previously known—the Seyfert Galaxy 3C 120 with the star BW Tau, and VR0 42 22 01 with BL Lac. In the search described, data were examined for 807 variable stars and checked for coincidences against A Master list of Radio Sources (1970) and other compilations. Only two coincidences were found, one of which concerned the source PKS 1514-24, identified as an E galaxy and discovered as the variable star AP Lib, the light curve of which for an earlier period is shown. Periods of very fast and chaotic variations are evident, including variations of up to 0.8 magnitude on a time scale of a few days or even a few hours. Comparisons are made with BL Lac. Photometric and spectrographic studies, as well as a search for radio variability, are needed to establish the properties of AP Lib and its possible similarity to BL Lac. (UK)

49628 OCCULTATION STUDIES 3C 245, MSH 14-121, AND MSH 19-21. Hazard, C.; Sutton, J. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astron. J.; 76: No. 7, 609-14(Sep 1971).

The structures of the radio sources 3C 245, MSH 14-121, and MSH 19-21 derived from occultation observations are described. Each source is double with the majority of the radio emission arising in structure ≤1 arc sec. 3C 245 is remarkably similar to 3C 273, having a small angular size component which coincides with a quasistellar object within the limits of the positional errors and extending from this component a narrow jet-like feature with a steeper spectral index than the narrow component. For MSH 14-121, however, the two components lie on opposite sides of the associated quasistellar object. MSH 19-21 appears to have a similar structure to 3C 273 but lies in an obscured region near the galactic plane and no identification is suggested. (auth)

49629 FOSSIL STROEMGREN SPHERES FROM SUPERNOVA EXPLOSIONS. Kafatos, Minas C.; Morrison, Philip (Massa-

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chusetts Inst. of Tech., Cambridge). Astrophys. J.: 168: No. 2, 195-201(1 Sep 1971).

Brandt et al. have shown that consistency in the combined observations of the Gum Nebula requires a giant H II region, presumably formed by the Vela X supernova explosion. Morrison and Sartori had concluded on the basis of their He II fluorescence theory of Type I supernovae that a giant H II region would be formed as result of the ultraviolet burst. (Bottcher et al., by integrating over the light curve, expect a smaller H II region.) Some consequences of the fluorescence model as illustrated by the Vela X and the Tycho supernovae are presented. It is concluded that such giant H II regions might not in general be as easily detectable as the Vela X region. The Tycho region may just be detectable in the O II, O III forbidden Optical lines or as a "hole" in the 21-cm emission-line profiles (the latter is already suggested in the data). These giant H II regions last appreciably longer than the continuum radio sources within them. Since no very large H II region is likely to be associated with a Type II supernova explosion, detection of giant H II regions around the Galaxy could give us the frequency of Type I explosions. (auth)

49630 CORRECT FORM OF EQUATION OF RADIATIVE TRANSFER IN A NONUNIFORM MAGNETOACTIVE PLASMA. Zheleznyakov, V. V. (Radiophysical Research Inst., Gorky, USSR). Astrophys. J.: 168: No. 2, 281-2(1 Sep 1971).

The criticism by Enome and Walsh of Zheleznyakov's equation of radiative transfer in a nonuniform magnetoactive plasma is shown to be incorrect. The discrepancy between the form of the equation given by Bekefi and that given by Zheleznyakov is a consequence of the ambiguous definition of specific intensity: Bekefi used specific intensity per unit solid angle along the group velocity vector while Zheleznyakov used specific intensity per unit solid angle along the wave vector. (auth)

49631 UPPER LIMITS OF LUMINOSITY OF CERTAIN EXTRAGALACTIC OBJECTS IN THE HARD γ-RAY REGION. Bratolyubova-Tsulukidze, L. S.; Kalinkin, L. F.; Melioranskii, A. S.; (and others) (Moscow State Univ.). JETP Lett. (USSR) (Engl. Transl.); 13: No. 10, 404-6(20 May 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 13: No. 10, 566-9(20 May 1971).

A scintillation–Cherenkov γ telescope for energies $\gtrsim$30 MeV was installed on Kosmos-208. In 152 hours of operation, this instrument registered 186 events interpreted as γ quanta in this energy range. Upper limits were established for the gamma flux from eleven extragalactic sources. (W.D.M.)

Solar Phenomena

49632 (AD-713856) FIVE-MINUTE OSCILLATIONS IN THE SOLAR MAGNETIC FIELD. Tanenbaum, Andrew S.; Wilcox, John M.; Howard, Robert (California Univ., Berkeley. Space Sciences Lab.). 30 Sep 1970. Contract N00014-69-A-0200-1016. 21p. NTIS.

Evidence for the existence of 5-minute oscillations in the photospheric and low-chromospheric magnetic fields is presented, their properties discussed, and a possible production mechanism suggested. (auth) (USGRDR)

49633 (AD-715456) BASIC SOLAR RESEARCH: THE SOLAR CHROMOSPHERE AND HIGH-ENERGY RADIATION. Final Report, July 1, 1956–September 30, 1970. Mohler, Orren C.; Prince, Helen D. (Michigan Univ., Ann Arbor. Dept. of Astronomy). Oct 1970. Contract Nonr-1224(19). 14p. NTIS.

A program directed towards basic research on the physics of the solar atmosphere and the effects of solar radiation on the Earth is reviewed. Continuing aid to ONR has played a significant role in the initiation and development of four general aspects of solar research: (1) maps and analyses of high-dispersion, high-resolution solar spectra obtained with the McGregor Vacuum Spectrograph of the McMath–Hulbert Observatory; (2) studies of solar activity with special emphasis on lambda-sweep spectroheliograms; (3) research and development leading to improvements in solar instrumentation; and (4) investigations in solar–terrestrial relationships. (auth) (USGRDR)

49634 (AD-716735) METHOD FOR ANALYZING DRIFTING RANDOM PATTERNS IN ASTRONOMY AND GEOPHYSICS: MOTION OF THE SOLAR WIND CLOSE TO THE SUN. Little, L. T.; Ekers, R. D. (Owens Valley Radio Observatory, Pasadena, Calif.). 1970. Contract N00014-67-A-0094-0008. 42p. NTIS.

The motion of interplanetary irregularities is derived in the range of solar elongation 6 to 40 $R_\odot$ from observations of interplanetary scintillation using spaced receivers at the Goldstone Deep Space Tracking Station, California. The acceleration of the irregularities is found to be consistent with that predicted for a Parker solar wind model having a coronal temperature of about 10^6 °K. There is evidence for high turbulent velocities of the irregularities that persist out to about 30 $R_\odot$ and which account for the "high-frequency tails" in the scintillation spectra observed by other workers. (auth) (USGRDR)

49635 (AD-716843) SPARK CHAMBER SPECTROMETRY AND SPACE RADIATION STUDIES. Final Report, October 15, 1965–October 14, 1970. Madey, Richard; Huetter, G. Thomas; Yushak, Stephen M. (Clarkson Coll. of Tech., Potsdam, N. Y. Dept. of Physics). 14 Jan 1971. Contract AF19(628)-5666. 53p. (CPDD-71-1; AFCRL-70-684). NTIS.

Advances in instrumentation based on the spark-chamber technique for making charged-particle studies of the aerospace environment have included the development of spark-discharge modules that are sealed against the space environment, a high-voltage generator with a long lifetime for use with spark chambers in space, a passive readout technique for spark-discharge counters, and a method of applying a clearing field that consumes no power. Analytical expressions are derived for the flux of protons within cylindrical-shell and slab-disk shields exposed to protons in space. Reported also are studies in space radiation dosimetry. (USGRDR)

49636 (AD-717349) EXTENDED CORONAL MAGNETIC FIELD. Wilcox, John M. (California Univ., Berkeley. Space Sciences Lab.). 16 Oct 1970. Contract N00014-69-A-0200-1016. 24p. NTIS.

The coronal magnetic field should contain many field lines connecting the photosphere to interplanetary space. A sharp boundary separates two adjacent sectors of opposite polarity. The large-scale structure of the corona is related to the photospheric sector pattern. The corona may frequently contain transient magnetic loops reaching out to five to ten solar radii. (auth) (USGRDR)

49637 (AD-717636) PHYSICS ON THE SOLAR CORONA. Final Report, 1967–January 31, 1971. Billings, Donald E. (Colorado Univ., Boulder. Dept. of Astro-Geophysics). Contract N00014-67-C-0290. 42p. NTIS.

Studies of extreme-ultraviolet spectroheliograms, green-line structures of coronal active regions, flare productivity as indicated by magnetic neutral lines, and Hα fibril structures in chromospheric active regions are discussed. The second part is a summary of the twenty-year program of research in coronal physics. (auth) (USGRDR)

49638 (AD-719944) ELECTRONICS IMPLEMENTATION OF THE SOLAR NEUTRON EXPERIMENT. Millard, Wayne A.; Simnett, George M.; White, R. Stephen (California Univ., Riverside. Inst. of Geophysics and Planetary Physics). Dec 1970. Contract N00014-69-A-0200-5001). 93p. NTIS.

Electronics used in the solar neutron experiment is described. The report includes an overall system block diagram, adders, discriminators, decision logic, pulse-height analyzers, time-of-flight circuitry, data encoder, and house-keeping circuitry such as the azimuth and temperature monitor circuits. Complete circuit diagrams with component values and photographs of some circuit boards and chassis are included. (auth) (USGRDR)

49639 (AD-721337) GYRORESONANCE OF SUPRATHERMAL ELECTRONS IN A COLLISIONLESS PLASMA. Gotwols, B. L. (Johns Hopkins Univ., Silver Spring, Md. Applied Physics Lab.). Oct 1970. Contract NOw-62-0604. 72p. (APL-TG-1135). NTIS.

Equations for the absorption coefficient and emissivity due to a tenuous component of suprathermal electrons gyrating in a magnetoactive plasma are given. An example is presented for the case where the plasma and gyrofrequencies are equal in order to illustrate the large magnitude (both positive and negative) and narrow bandwidth of the absorption coefficient when the complex doppler effect comes into play. Maximum growth rate is found when the wave normal makes a small angle with the background magnetic field. It is pointed out that the large value of the longitudinal electric field makes uncertain, without further analysis, the intensity of the radiation that can escape from the plasma. A numerical example is given where the gyrofrequency exceeds the plasma frequency, and the electrons exhibit an anisotropic momentum distribution function. The resultant negative absorption coefficient is shown to be plausible as a generation mechanism for the narrow-bandwidth component of decimetric-wavelength solar bursts. The relevance of amplified gyroradiation as an explanation for Type I bursts is discussed. (auth) (USGRDR)

49640 (AD-722467) ALBEDO NEUTRON COMPONENT OF THE EARTH'S RADIATION ENVIRONMENT. Final Scientific Report, May 1, 1968–April 30, 1970. Occhialini, Giuseppe P. S. (Milan Univ. (Italy). Istituto di Scienze Fisiche). 23 Dec 1970. Contract F61052-68-C-0050. 21p. (AFCRL-71-133). NTIS.

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A high-energy neutron detector was constructed to measure the solar neutron flux, under quiet or active Sun conditions, over the energy range 10 to 200 MeV. The detector consists of a plastic scintillator (the central detector) with anticoincidence shield. The central detector is surrounded by an aluminum sheath, whose purpose is to bring to rest the recoil protons, thus diminishing the self-gating effects and keeping the detection efficiency high enough at high energies. No finite flux was detected and an upper limit of 0.0055N/cm^2 was established for the continuous flux, which is comparable (although somewhat lower) with another upper limit of 30N/cm^2 established for a 1N importance optical flare. Also, the omnidirectional intensity of atmospheric gamma rays, converted in the aluminum sheath, was measured at ballon altitudes at three energy levels. A value of 0.33/cm^2 sec was found for energies greater than 20 MeV. The results are in good agreement with those obtained by Fichtel et al. (1969). (auth) (USGRDR)

49641 (CSIRO-Trans-10552) MAGNETIC FIELDS IN THE SOLAR CHROMOSPHERE. Vyal'shin, G. F.; Krat, V. A. Translated by G. Losonci (Commonwealth Scientific and Industrial Research Organization, Australia), from Izv. Gl. Astron. Observ. Pulkove; 24: No. 2, 26-34(1965). 17p. Dep. NTIS (U. S. Sales Only).

Observations of the Sun led to the following conclusions. Large-scale photospheric and chromospheric motions are taking place with a characteristic dimension of about 27,000 km. The linear extension of magnetic field fluctuations coincided with the extension of radial velocity fluctuations. Large-scale motions in the photosphere were of the nature of gravity-acoustic waves. The field strength in "hydrogen" elements of the chromosphere was several times higher than in the photosphere. The magnetic field of sunspots in the chromosphere, determined by measurement of its longitudinal component was markedly displaced relative to the photospheric spot field. The mean gradient of spot fields in the lower chromosphere was 1.2 Oe/km. (Australia)

49642 INVESTIGATION OF FAINT METEOR CHARACTERISTICS BY THE RADIO METHOD. Kashcheev, B. L.; Dudnik, B. S.; Novoselova, N. V.; Tkachuk, A. A. (Polytechnic Inst., Kharkov). Dokl. Akad. Nauk SSSR; 196: No. 4, 805-7(1 Feb 1971). (In Russian).

A radioelectronic complex was created at Kharkov during the period from 1965 to 1967 in order to observe meteors to the +14m level. The complex contains a synchrogenerator, a powerful multistage transmitter, directional transmitting and receiving antennas, radio receivers, and signal retransmitters with feeder antenna devices, shielding systems, and multichannel photorecorders. The complex, operating in the 22- to 23-MHz range, enables the meteors to be counted and their speed and radiance to be measured. The speed is determined by the pulse-diffraction method. Great daily variations were found in the number of meteors during the 1968–69 period; the maximum number was observed at the time of the appearance of the antisolar and apex regions. Recording of the amplitude of meteors at several levels of sensitivity permitted determination of the parameters of the mass distribution of meteoritic bodies. (TTT)

49643 SOLAR COSMIC RAYS. Fichtel, C. E. (Goddard Space Flight Center, Greenbelt, Md.). Phil. Trans. Roy. Soc. London, Ser. A; 270: No. 1202, 167-74(1971).

One of the most striking features of solar cosmic-ray events is the tremendous variation in many of their characteristics and the related difficulty of precise interpretation. A feature of solar cosmic rays which does seem to be constant from event to event and within an event is the relative abundances of the multicharged nuclei with the same charge: mass ratio. Observations of the composition of solar particles and their interpretation are discussed. A brief discussion on the propagation of the energetic solar particles including a few comments on the source region, is also included. (auth) (UK)

49644 REVIEW OF MODELS OF THE SOLAR PHOTOSPHERE AND LOW CHROMOSPHERE: THE TEMPERATURE-HEIGHT PROFILE. Lambert, D. L. (Univ. of Texas, Austin). Phil. Trans. Roy. Soc. London, Ser. A; 270: No. 1202, 3-21(1971).

Empirical and theoretical models of the photosphere and low chromosphere are reviewed, with especial reference to the Bilderberg continuum atmosphere. The observations and analysis of the continuous spectrum are emphasized. A minimum electron temperature of 4300K at $\lg \tau_0 \approx -4$ is suggested by new observations in the ultraviolet and far infrared. (auth) (UK)

49645 ABUNDANCE OF IRON IN THE PHOTOSPHERE. Unsoeld, A. (Univ., Kiel). Phil. Trans. Roy. Soc. London, Ser. A; 270: No. 1202, 23-8(1971).

For many years there has been a discrepancy of about a factor of ten between the solar iron abundance obtained from the Fraunhofer spectrum of the photosphere and that obtained from the extreme uv lines. Similar inconsistencies for the iron abundance in meteorites, especially carbonaceous chondrites of type I, have been noted. The way in which these discrepancies have been removed by recent work is described, and some further consequences are pointed out. (auth) (UK)

49646 HIGH-RESOLUTION SOLAR ULTRAVIOLET SPECTRUM BETWEEN 200 AND 220 nm. Boland, B. C. (United Kingdom Atomic Energy Authority, Abingdon, Eng.); Jones, B. B.; Wilson, R.; Engstrom, S. F. T.; Noci, G. Phil. Trans. Roy. Soc. London, Ser. A; 270: No. 1202, 29-46(1971).

A high-resolution solar spectrum in the range 200 to 220 nm was recorded with an echelle spectrograph launched in a Sun-pointing Skylark rocket. The data are presented as intensity–wavelength plots, together with a wavelength list and proposed identifications. A broad absorption feature at 212.4 nm is assigned to a single source and an intensity analysis confirms this to be the nonresonance Si I line at 212.412 nm. The discontinuity in the continuum intensity near 208.7 nm is revealed with high resolution for the first time and is assigned to the photoionization edge of Al I. An analysis shows that its intensity drop and wavelength position can only be explained by adjustments to the solar model in the region $0.001 < T_{5000} < 0.2$. (auth) (UK)

49647 HIGH-RESOLUTION INTERFEROMETRIC STUDIES OF THE SOLAR MAGNESIUM II DOUBLET SPECTRAL REGION. Bates, B. (Queen's Univ., Belfast. United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phil. Trans. Roy. Soc. London, Ser. A; 270: No. 1202, 47-53(1971).

The importance of the Mg II resonance lines λ279.55 and 280.27 nm in uv astronomy is emphasized and with the extension of interference spectroscopy into the far-uv, sophisticated optical techniques can now be employed at these wavelengths. These lines are sensitive indicators of chromospheric phenomena. Previous work in this field is briefly reviewed, and results obtained from a balloon-borne improved echelle interferometer spectrograph flown in Nov. 1969 are reported. The resolution limit was improved to 1.6 pm, and the number of fringes, and hence line profiles, simultaneously recorded for each spectral line was increased from 10 to 20. (UK)

49648 MEASUREMENT OF THE BRIGHTNESS TEMPERATURE OF THE SUN IN THE RANGE 65 TO 180 cm^{-1}. Clark, T. A.; Courts, G. R.; Jennings, R. E. (University Coll., London). Phil. Trans. Roy. Soc. London, Ser. A; 270: No. 1202, 55-8 (1971).

Measurements using a Michelson interferometer, and employing Fourier-transform multiplex techniques, from a balloon at the NCAR Balloon Flight Station, Texas, in Sept. 1969. Graphs are presented showing low-resolution (~10 cm^{-1}) solar and sky spectra, the solar spectrum at resolution ~1 cm^{-1}, and solar brightness temperature/wave number. A decreasing temperature with decreasing wave number was indicated. (UK)

49649 OBSERVATIONS OF THE EXTREME-ULTRAVIOLET SOLAR SPECTRUM. Tousey, R. (Naval Research Lab., Washington, D. C.). Phil. Trans. Roy. Soc. London, Ser. A; 270: No. 1202, 59-70(1971).

The present state of knowledge of the Sun's euv spectrum is reviewed, and areas for future work are indicated. Recent euv spectroheliograms, including one that shows an importance 2N flare, are discussed. (auth) (UK)

49650 INTERPRETATION OF EXTREME-ULTRAVIOLET EMISSIONS FROM THE SUN. Allen, C. W. (London Univ.). Phil. Trans. Roy. Soc. London, Ser. A; 270: No. 1202, 71-5 (1971).

A review is given to consider the analysis of euv space observations for the interpretation of the quiet Sun, active regions, and flares. It becomes necessary to make some simple assumptions concerning the components in order that they can be measured consistently. Some descriptive models are given that are complete enough to represent the complex varying Sun at all times, but simple enough to be expressed quantitatively in a few numbers. The aim is to interpret all euv observations on the basis of these models and to regard them as the norm. Exceptional phenomena are regarded as variations from the models. Ideally, all intensity and flux measurements would be made within individual spectrum lines or in continua at specified wavelengths. However, many valuable observations are based on broad spectral regions and it is necessary to devise methods for interpreting them. (auth) (UK)

49651 MANIFOLD STRUCTURE OF THE CHROMOSPHERE AND CORONA. Zirin, H. (California Inst. of Tech., Pasadena).

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Phil. Trans. Roy. Soc. London, Ser. A; 270: No. 1202, 77-80 (1971).

It is thought that magnetic influences lead to nonuniformity and fine structure in the chromosphere and corona. Photographs are reproduced of the chromosphere in the center of Hα, Hα + 0.05 nm, and the Zeeman field. Regions of chromospheric structure indicated are: (1) the quiet chromospheric network, with average field strength <5 G, characterised by an irregular network marked by spicules and vigorous oscillatory motion; (2) high-field regions, with average field >5 G, with the cells appearing as bright plages; the field may be marked by dark fibrils, and the bright phages are made up of thousands of bright points that oscillate in brightness and position; (3) enhanced network regions, of average magnetic field >5 G, made up of a regular network of fields >5 G; (4) horizontal field regions, masked by long fibril structures, with no apparent network or cellular structure. Great regularity is found in the chromospheric structure. Other special types of solar activity of interest shown by the photographs are briefly mentioned. The present evidence indicates that the vertical fields are a pathway for energy flow to the corona. The role of spicules in the concept of the chromosphere is briefly discussed. The limited knowledge concerning the structure of the corona is briefly reviewed. The observed large streamers appear to be connected with large-scale magnetic features and, in particular, with the unipolar regions that trail active regions; and like the chromospheric structure, the coronal structures also follow the magnetic fields. (UK)

49652 STRUCTURE OF CHROMOSPHERE–CORONA TRANSITION REGION FROM LIMB AND DISK INTENSITIES. Burton, W. M.; Jordan, Carole; Ridgeley, A.; Wilson, R. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phil. Trans. Roy. Soc. London, Ser. A; 270: No. 1202, 81-98(1971).

During a rocket flight in April 1969, spectra were obtained of a region of the solar disk and at the solar limb. The absolute disk intensities derived from these data were used to compute models of the transition region, making the assumptions that the relative abundances of different elements remain constant throughout the atmosphere, and that the electron pressure varies according to the equation of hydrostatic equilibrium. The models obtained are characterized by very steep temperature gradients. The relative intensities of emission lines in the disk and limb spectra enabled the height of the emitting regions to be determined independently of the above assumptions, and independently of atomic data and absolute intensities. A comparison is made of the structure found by the two methods and, within the accuracy of the present data, these are consistent. Emission from low-temperature (~10^4 K) material is observed from heights up to 10^4 km above the transition region, and this probably originates in spicules. (auth) (UK)

49653 MEASUREMENTS OF ELECTRON TEMPERATURE IN THE SOLAR CHROMOSPHERE AND CORONA. Heroux, L.; Cohen, M. (Air Force Cambridge Research Labs., Bedford, Mass.). Phil. Trans. Roy. Soc. London, Ser. A; 270: No. 1202, 99-107(1971).

The electron temperatures at which the lithium-like ions O VI, Ne VIII, and Mg X are formed in the solar chromosphere and corona were determined in a rocket experiment by measuring the intensity ratio of pairs of emission lines from the same ion. The ratios compared the intensity of the resonance multiplet 2s–2p with the multiplets 2s–3p, 2p–3s and 2p–3d. The theoretical dependence of the three ratios on electron temperature was determined by assuming that the free electrons have a Maxwellian distribution of velocities and that the electron distribution over the excited levels is given by a coronal-type equation. Collisional excitation cross sections given by Bely and Burke et al. were used in the calculation. The experimental temperatures are in fairly good agreement with the theoretical temperatures for the maximum abundance of the ions obtained by assuming ionization balance. (auth) (UK)

49654 ROLE AND NECESSITY OF OPTICAL SPACE OBSERVATIONS IN SOLAR PHYSICS. Kiepenheuer, K. O. (Fraunhofer Institut, Freiburg i. B.). Phil. Trans. Roy. Soc. London, Ser. A; 270: No. 1202, 109-16(1971).

It is shown that, for a quantitative investigation of the physical processes producing the chromospheric structures, an angular resolution of 0.2 sec in the extreme uv as well as in the magnetic-field measurement is indispensable. The same requirements also apply to the study of the primary flare process. The realization of such complex optical space projects will need the integration of ground, balloon, and space work. (auth) (UK)

49655 EXTREME-ULTRAVIOLET EMISSION DURING FLARES. Glencross, W. M. (University Coll., London).

Phil. Trans. Roy. Soc. London, Ser. A; 270: No. 1202, 117-25 (1971).

A number of time profiles are presented that show how the flux of radiation in the wavelength bands 0.1 to 0.3 nm, 0.3 to 0.9 nm, 0.8 to 1.6 nm and at 30.4 nm changes during flares. The first sign of a flare is often a decrease of flux at 30.4 nm followed by an increase in the x-ray emission. In general, the higher the photon energy, the earlier the peak flux is reached, although any increase observed at 30.4 nm seems to peak before the x-ray flux. It is concluded that a model in which a mass of gas in the upper chromosphere is heated by shock waves or incident energetic particles does not explain the observations. What appears to be a more suitable model is suggested. Cool plasma from low in the chromosphere passes through a region of magnetic instability and is heated during the passage. In this way the material of the x-ray emitting region is heated to a high temperature a little at a time. The intensity of x-rays observed in each waveband is proportional to the volume of gas produced up to that time at the corresponding temperature. As the instability decays the gas passing through it can no longer be heated to the temperatures reached earlier, and the emission of longer wavelength x-rays becomes dominant. The emission of γ rays and radio waves can also be explained by this model. (auth) (UK)

49656 HELIUM-LIKE ION FORBIDDEN LINE EMISSION AND SOLAR ACTIVE REGIONS. Freeman, F. F.; Gabriel, A. H.; Jones, B. B.; Jordan, Carole (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phil. Trans. Roy. Soc. London, Ser. A; 270: No. 1202, 127-33(1971).

A theory has been developed for interpreting the intensity of the $1s^2\ ^1S-1s2s\ ^3S$ forbidden line in helium-like ions in terms of electron density at the source. In a recent soft x-ray rocket experiment this transition was observed simultaneously from C V, N VI and O VII. New values for the forbidden transition probabilities are derived in a semi-empirical manner using the data. The new values lead to derived solar densities in active regions of between 10^{11} and 10^{13} cm^{-3}. (auth) (UK)

49657 NEW RESULTS OF X-RAY FLARE STUDIES. Mandelstam, S. (Lebedev Inst. of Physics, Moscow). Phil. Trans. Roy. Soc. London, Ser. A; 270: No. 1202, 135-42(1971).

Polarization of x-ray emission was found in the wavelength band around 0.1 nm during the rising phase of three x-ray flares. This shows that, in the x-ray-flare regions, directed electron beams are present. It was established that x-ray-flare regions generally have a filamentary structure with bright knots and rapid spatial alterations. Very short x-ray bursts were frequently observed in some flare regions. The region of an x-ray flare may be considered as a two-component plasma: the main component having a temperature of about 7 to 9×10^6 K, an emission measure of about 0.02 to 0.1 Baumbach, and an electron density 1 to 2×10^{10} cm^{-3}, and containing dispersed hot (up to 15 to 30×10^6 K) small nuclei having an overall emission measure one order of magnitude smaller. (auth) (UK)

49658 SOLAR-FLARE X-RAY SPECTRA. Neupert, W. M. (Goddard Space Flight Center, Greenbelt, Md.). Phil. Trans. Roy. Soc. London, Ser. A; 270: No. 1202, 143-55(1971).

The solar x-ray spectrum provides a versatile method for determining physical conditions in the lower corona and corona/chromosphere interface that are associated with the chromospheric (Hα) flare phenomenon. Information is contained both in the continuum and line emission existing at these wavelengths. Continuum emission is predominant below 0.13 nm because of the relatively low solar abundance of heavy elements capable of producing line emission at these wavelengths. During the initial phase of an x-ray event this continuum frequently appears in short, often quasi-periodic bursts whose spectrum is best described by a power law to 100 keV and decreasing more rapidly at high energies. The electron spectrum apparently responsible for these bursts has many similarities to that required for the production of type III radio bursts. The emission of flare-associated soft x-ray radiation (both line and continuum radiation) begins at the time of hard x-ray bursts, but reaches maximum one to several minutes later. Line emission from ions up to Ni XXVII in the helium-like ion sequence and up to Fe XXVI in the hydrogen-like ion sequence was observed during large flares. The evolution of the plasma in which this radiation originates can be studied by comparing emission lines in the same or adjacent stages of ionization of an element. From such observations it is concluded that a steady-state condition rarely, if ever, exists in the x-ray emitting regions associated with a solar flare. (auth) (UK)

49659 SOLAR-PARTICLE EVENTS. Svestra, Z. (Astronomical Inst., Ondrejov, Czech.). Phil. Trans. Roy. Soc. London, Ser. A; 270: No. 1202, 157-65(1971).

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It is stated that the very sensitive detectors employed in satellite and space-probe studies have revealed that the emission of particles from the Sun is a much more frequent phenomenon than had been supposed and that the recorded particle events differ greatly in character. The variety of phenomena is discussed and correlation is attempted. Amongst matters discussed are: permanent emission of protons with energy ~1 MeV associated with specific active regions; classification of discrete particle events into prompt and delayed events; prompt solar-proton events; cosmic-ray flares; proton-flare events; satellite-sensed events; electron events (relativistic and nonrelativistic electrons); and pure electron events. (UK)

49660 PRODUCTION OF SOLAR AND STELLAR CHROMOSPHERES AND CORONAE. de Jager, C. (Astronomical Inst., Utrecht). Phil. Trans. Roy. Soc. London, Ser. A: 270: No. 1202, 175-82(1971).

Knowledge of the detailed field of turbulence in the solar granulation, and of the consequent photospheric mechanical flux, is one of the basic elements for understanding the solar chromosphere and corona. The other element is constituted by the structure and magnetic fields of the supergranular network, since the coarse mottles at the supergranular boundaries seem to yield a mechanical flux nearly an order of magnitude larger than that of the supergranular cell regions. In the nonmagnetic solar regions the upper photospheric mechanical flux is about 0.1 J cm^{-2} s^{-1}. This flux is equal to that emerging from the low-chromospheric vibrations, and it seems not to be related to the observed microturbulent motions. Above such regions the chromosphere may be fairly thin, not exceeding 1000 or 2000 km. The precise thickness and detailed structure of the chromospheric layers can only be determined from consideration of the interplay of the downward conductive flux with the dissipational losses of the up- and downward mechanical fluxes, and the radiative losses of the chromospheric matter. The greater apparent thickness of the chromosphere at the limb is due to the accumulated influence of the spicules seen from the side. Lack of knowledge of stellar photospheric inhomogeneities and fields handicaps a reliable prediction of stellar chromospheres and coronae. A few attempts, however, are made, and predicted x-ray fluxes from coronae of some nearby stars are given. (auth) (UK)

49661 SOLAR MICROWAVE BURSTS: HOMOLOGOUS EVENTS FROM DIFFERENT ACTIVE CENTRES. Scalise, E.; Basie, D.; Paes de Barros, M. H.; Kaufmann, P. (MacKenzie Univ., Sao Paulo, Brazil). Nature (London) Phys. Sci.; 232: No. 29, 56-7(19 Jul 1971).

A case of homologous radio bursts arising from different centers of solar activity is reported. It was observed with the 7-GHz solar polarimeter at Itapetinga Radio Observatory, Sao Paulo. Also recorded were the phase advances at two very low frequencies, confirming the simultaneous emission of hard x rays that cause ionization in the lower ionosphere. The data suggest that the events could not have been associated with the same McMath plage. The first event was on May 5, 1971, and the homologous event on May 14. The variations of flux with time for the two events were remarkably similar, and the events were examples of unusually complex bursts superimposed on long-enduring events. Data are given showing a correspondence between flare importances, their intensities in the x-ray and radio regions, and the phase advances at very low frequencies. This occurrence of events widely spaced in time, but showing remarkable similarities in their profiles and the manner in which they decayed, suggests that the concept of homology can be extended to cover different active centers; and the occurrence of homologous events appears to be related to the similar magnetic configurations that occur close to flares. (UK)

49662 SPECTRA OF THE DIFFERENT TYPES OF SOLAR MICROWAVE BURSTS. Das Gupta, M. K.; Sarkar, S. K. (Univ. of Calcutta). J. Roy. Astron. Soc. Can.: 65: No. 4, 152-8(Aug 1971).

Spectra of the different types of solar microwave bursts were examined separately using simultaneous bursts recorded at 1415, 2695, 4994, 8800, 15,400, and 35,000 MHz by the Sagamore Hill Radio Observatory during the period December 1967 to March 1970. Simultaneous bursts that maintain their identity as belonging to any of the commonly occurring morphological types (impulsive, gradual rise and fall, post-burst increase, complex, each with or without fluctuations) for at least five different frequencies were selected and grouped for spectral study. The variation of peak flux and of energy (average flux × duration) with frequency for the individual bursts under different morphological types were examined. The important results obtained are: (1) impulsive bursts (Types 1 and 3) are found to be predominant in retaining their same morphological identity throughout the entire frequency range; (2) spectra of bursts can be of four different types and are found not to have any preference for any of the morphological types: (3) spectral distributions of peak flux and energy are found to be identical in nature; and (4) of the four different spectral types, "inverted-U" and "zig-zag" types are predominant, respective percentages being 51% and 38%. (auth) (Canada)

49663 INTERPLANETARY LYMAN-ALPHA: THEORY AND EXPERIMENT. Fehlau, P. E.; Chambers, W. H.; Fuller, J. C.; Kunz, W. E. (Los Alamos Scientific Lab., N. Mex.). Nature (London): 232: No. 5307, 179-80(16 Jul 1971).

Some alleged errors and misinterpretations in discussions of the Vela 4 Lyman-α scattering experiment (Nature, 225: 713(1970)) by Bowers (Nature, 228: 1182(1970)) and Blum and Pahr (Astrophys. Lett., 6: 127(1970)) are pointed out. (UK)

49664 RADIATION FROM A HIGH-TEMPERATURE, LOW-DENSITY PLASMA: X-RAY SPECTRUM OF THE SOLAR CORONA. Tucker, Wallace H.; Koren, Marvin (American Science and Engineering, Cambridge, Mass.). Astrophys. J.: 168: No. 2, 283-311(1 Sep 1971).

The results of calculations of the 0.5 to 70 Å x-ray spectrum of a high-temperature, low-density plasma are presented. The temperature range was 6×10^5 to $10^{8.5}$K, and the elemental abundances characteristic of the solar corona were assumed. The processes of line emission following electron collisional excitation, radiation resulting from recombination, bremsstrahlung, and two-photon decay following the excitation of the metastable 2S state in hydrogenic and helium-like ions were considered. (auth)

49665 HARVARD-SMITHSONIAN REFERENCE ATMOSPHERE. Gingerich, O. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.); Noyes, R. W.; Kalkofen, W.; Cuny, Y.). Solar Phys.; 18: No. 3, 347-65(Jul 1971).

A model of the solar atmosphere in the optical depth range from $\tau_{5000} = 10^{-8}$ to 25 is presented. It combines an improved model of the photosphere that incorporates recent euv observations with a new model of the quiet lower chromosphere. The latter is based on OSO 4 observations of the Lyman continuum, on infrared observations, and on eclipse electron densities. The model differs from the Bilderberg Continuum Atmosphere (BCA) in the low chromosphere ($\tau_{5000} < 10^{-4}$), where deviations from local thermodynamic equilibrium in hydrogen and carbon have been taken into account. It also differs in the transition region between the chromosphere and the photosphere ($10^{-4} < \tau_{5000} < 10^{-2}$), where the temperature is lower than in the BCA, and in the convective region ($\tau_{5000} \gtrsim 2$), where the temperature is higher than in the BCA. (auth)

49666 TRUE CENTRAL INTENSITIES OF FRAUNHOFER LINES. Brault, J. W.; Slaughter, C. D.; Pierce, A. K.; Aikens, R. S. (Kitt Peak National Observatory, Tucson, Ariz.). Solar Phys.; 18: No. 3, 366-78(Jul 1971).

From the observations made at Kitt Peak the true central intensities of 40 Fraunhofer lines distributed between λλ 3083 to 7699, for the center of the solar disk, are derived and given in tabular form. The paper includes a description of the optical system—telescope and spectrograph. The methods of observation and reduction of the data are discussed. (auth)

49667 MEASUREMENTS OF OSCILLATORY AND SLOWLY VARYING COMPONENTS OF THE SOLAR VELOCITY FIELD. Sheeley, N. R. Jr. (Kitt Peak National Observatory, Tucson, Ariz.); Bhatnagar, A. Solar Phys.; 18: No. 3, 379-84(Jul 1971).

Spectroheliograms with high spatial resolution are presented to illustrate the decomposition of the solar velocity field into its oscillatory and slowly varying components. An analysis of data obtained in the lines FeI λ 5434 and FeII λ 4924 yields essentially the same principal results: (1) Spectroheliograms of the oscillatory component have a mottled appearance of rising and falling elements ranging from 2000 km to 3000 km in size. These elements oscillate vertically with a period in the range 275 to 300 s and an amplitude of 0.5 km/s. Although most oscillations last two cycles, some have been observed for as many as four cycles. (2) Spectroheliograms of the slowly-varying component show a velocity granulation pattern whose spatial properties correspond closely to those of the photospheric granulation visible on direct photographs of the Sun. The velocity granules are approximately 1000 km in diameter and rise relative to their intergranular spaces with speeds that are typically 0.6 km/s, but which may occasionally be as large as 0.9 km/s. Most velocity granules seem to live for at least 10 min with many lasting 10 to 30 min, and a few of the biggest and fastest moving lasting 30 min to 1 hr. It is concluded that spectroheliograms of the slowly-varying com-

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ponent represent the velocity field of the photospheric granulation. (auth)

49668 BRIGHT–DARK ASYMMETRY IN SOLAR GRANULATION. Parvey, Michael I. (Indiana Univ., Bloomington); Musman, Steven. Solar Phys.; 18: No. 3, 385-90(Jul 1971).

Although a positive print of solar granulation gives the impression of bright irregular areas on a dark background, this impression is highly subjective and depends upon the nature of the photographic process. An objective method was developed for comparing bright and dark features and applied to 40,000 elements from a granulation photograph. Each element had dimensions of 150 km by 150 km. It was found that dark features were fewer in number, larger, and had larger perimeter-to-area ratios than the bright features. The statistical confidence level of the results exceeded 99%. The results are consistent with the subjective impression that granulation is composed of bright features separated by dark lanes. (auth)

49669 HYDROGEN IONIZATION AND n = 2 POPULATION FOR MODEL SPICULES AND PROMINENCES. Poland, A.; Skumanich, A.; Athay, R. G.; Tandberg-Hanssen, E. (National Center for Atmospheric Research, Boulder, Colo.). Solar Phys.; 18: No. 3, 391-402(Jul 1971).

Using slab model atmospheres that are irradiated from both sides by photospheric, chromospheric, and coronal radiation fields, the ionization and excitation equilibrium for hydrogen was determined. The model atom consists of two bound levels (n = 1 and n = 2) and a continuum Ly-α was assumed to be optically thick with the transition in detailed radiative balance. The Balmer continuum was assumed to be optically thin with the associated radiative ionization dominated by the photospheric radiation field (T_{rad} = 5940 K). The ionization equilibrium was determined from an exact treatment of the radiative transfer problem for the internally generated Ly-c field and the impressed chromospheric and coronal field (characterized by T_{rad} = 6500 K). The calculations corroborate the hypothesis that N_2, the n = 2 population density, is uniquely determined by the electron density $\langle N_e \rangle$. Ionization curves are presented for 6,000, 7,500, and 10,000 K models ranging in total hydrogen density from $1 \times 10^{10}/cm^3$ to $3 \times 10^{12}/cm^3$. Using these curves it is possible to obtain the total hydrogen density from the n = 2 population density in prominences and spicules. (auth)

49670 MOTIONS OF Hα SPICULES ALONG THE SOLAR LIMB. Nikolskii, G. M.; Platova, A. G. (Lab. of Solar Activity, Moscow). Solar Phys.; 18: No. 3, 403-9(Jul 1971).

A series of Hα-spectrograms obtained with the 21-in. Lyot coronagraph was examined. Measurements of relative distances between spicules (nearly 50 features) embraced the time interval of about 21 min (38 pictures). It was found that spicules oscillate along the limb with a characteristic time interval (period) about 1 min, characteristic amplitude of 1 arc sec, and velocities about 10 to 15 km/s. The oscillations showed no correlation for distant spicules. (auth)

49671 INTENSITY DISTRUBUTION OF THE D_3 HELIUM LINE NEAR THE SOLAR LIMB. Gulyaev, R. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Solar Phys.; 18: No. 3, 410-16(Jul 1971).

Cinematographic observations of the slitless flash spectrum near the D_3 helium line were performed in Yurgamysh at the total solar eclipse of September 22, 1968. The intensity distribution of the D_3 line was obtained with a height resolution of 44 km within the height interval between −3400 and +1700 km above the limb. The absorption line D_3 on the disk near the limb was discovered. (auth)

49672 COMPLEXES OF ACTIVITY OF THE SOLAR CYCLE AND VERY-LARGE-SCALE CONVECTION. Yoshimura, Hirokazu (Tokyo Univ.). Solar Phys.; 18: No. 3, 417-33(Jul 1971).

The magnetic field pattern associated with large-scale convective motions, which are much larger than the supergranules and have been conceived as a source of maintenance of the solar differential rotation, is calculated in the framework of a slowly and differentially rotating thin spherical shell, including the effects of thermal conductivity and viscosity. The approximations of Boussinesq are used and the initial state of the magnetic field is assumed to be purely toroidal. The resulting magnetic field pattern rotates rigidly on the differentially rotating Sun with some phase delay to the convective pattern, if it is assumed that only the predominant mode with the maximum growth rate is actually realized in the solar convection zone. The obtained magnetic and convective patterns and their properties seem to explain naturally the various aspects of large-scale ordering of solar activity such as the existence and behavior of complexes of activity, the rigid body rotation of proton-flare active longitudes, their association with UMR's, the existence of ghost and mirror image of UMR's themselves and the fact that the rotational period derived from sunspot data is shorter than that derived spectroscopically from fluid velocity. (auth)

49673 OBSERVATIONS OF STRAY-LIGHT AND SUNSPOT INTENSITIES DURING THE MERCURY TRANSIT OF MAY 9, 1970. Mattig, W. (Fraunhofer Inst., Freiburg i. B.). Solar Phys.; 18: No. 3, 434-42(Jul 1971).

In order to test the usual method for correcting sunspot intensity measurements for stray light, during the Mercury transit of May 9, 1970, the intensities of Mercury, a sunspot umbra, and the aureole were measured. The direct observations resulted in Mercury intensities $<0.06\ I_{\odot}$ and aureole intensities $<0.01\ I_{\odot}$. The stray light correction to the spot intensities was $<(0.03 \pm 0.01)\ I_{\odot}$. The main contribution to the stray light on the solar disc is shown to be produced by a spread-function with a half width of 10 arc sec. Consequently, for stray light corrections the range $R \leq R_{\odot} + 20''$ in the aureole has to be measured very precisely; furthermore, a remarkable fraction of the stray light in the center of an umbra originates from the surrounding penumbra. (auth)

49674 SUNSPOT INTENSITY OBSERVATIONS DURING THE MAY 9, 1970 MERCURY TRANSIT. Maltby, P.; Staveland, L. (Univ. of Oslo). Solar Phys.; 18: No. 3, 443-9(Jul 1971).

The intensity of a sunspot was measured in eight wavelength regions during the Mercury transit of May 9, 1970. The observations were corrected for scattered light in the Earth's atmosphere as well as in the instrument using two different methods plus a combination of these. One method consists of using Mercury as a calibration spot. In the second method the corrections for scattered light were determined from solar-limb observations. (auth)

49675 PHOTOMETRY OF OUTER SOLAR CORONA FROM LUNAR-BASED OBSERVATIONS. Bohlin, J. David (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.). Solar Phys.; 18: No. 3, 450-7(Jul 1971).

Two-dimensional isophotes of the extreme solar corona ($r_{max} \sim 45\ R_{\odot}$) were derived from integrated vidicon pictures taken from the Moon's surface by the unmanned probes Surveyors 6 and 7. These data were calibrated through use of previously published values for the coronal brightness gradient along the ecliptic. The resulting structure of the outer corona is compared to ground-based observations of the innermost corona ($1.125 \leq r/R_{\odot} \leq 2.0$) made by the High Altitude Observatory K-coronameter. The possible existence of a streamer seen by Surveyor 7 is analyzed over the region $15 \leq r \leq 22.5\ R_{\odot}$. (auth)

49676 COMPARISON OF SOLAR EUV INTENSITIES AND K-CORONAMETER MEASUREMENTS. Withbroe, George L. (Harvard Coll. Observatory, Cambridge, Mass.). Solar Phys.; 18: No. 3, 458-73(Jul 1971).

Characteristics of the emission observed above the solar limb in four euv lines, Si XII λ499, Mg X λ625, Ne VIII λ770, and O VI λ1032 are discussed. The mean temperature of the corona derived from the ratios of the intensities of Si XII λ499 and Mg X λ625 is 1.8 million K. There do not appear to be significant temperature differences in regions with low euv intensities and those with high euv intensities, suggesting that the euv emission from the lithium-like ions depends primarily on the integral of n_e^2 along the line of sight. The euv data are compared with K-coronameter measurements in order to yield new estimates of the abundances of Si, Mg, Ne, and O relative to hydrogen. Within the uncertainties of the analysis, these coronal abundances are in agreement with the corresponding photospheric values. (auth)

49677 SATELLITE LINES IN THE SOLAR X-RAY SPECTRUM. Neupert, Werner M. (Goddard Space Flight Center, Greenbelt, Md.). Solar Phys.; 18: No. 3, 474-88(Jul 1971).

Observations of solar x-ray line emission using crystal spectrometers during a large chromospheric flare have provided a list of wavelengths with a precision of 0.003 Å in first order of diffraction and correspondingly better in higher orders. In addition to the resonance, intersystem ($1\ ^1S_0 - 2\ ^3P_1$) and forbidden ($1\ ^1S_0 - 2\ ^3S_1$) transitions of ions of the He I isoelectronic sequence, satellite lines arising from ions in the Li I, Be I, and B I isoelectronic sequences were recorded. These satellite features are most prominent in the iron spectrum. Apparent decreases in the ratio of forbidden and intersystem line intensities of Mg XI and Si XIII during the flare were used to derive electron densities possibly as high as $1 \times 10^{13}\ cm^{-3}$ in the Mg XI emitting region and $1 \times 10^{14}\ cm^{-3}$ in the Si XIII region during the event. A search for satellite lines on the long-wavelength side of the Lyman-alpha line of H I-like ions yielded no positive identifications. (auth)

49678 DEDUCTION OF ENERGY SPECTRA OF NON-THERMAL ELECTRONS IN FLARES FROM THE OBSERVED DYNAMIC SPECTRA OF HARD X-RAY BURSTS. Brown, John C. (Univ. of Glasgow). Solar Phys.; 18: No. 3, 489-502(Jul 1971).

The derivation of dynamic spectra of high-energy electrons in flares from high-resolution hard x-ray observations is considered. It is shown that the Bethe–Heitler formula for the electron-proton bremsstrahlung cross section over the 20 to 100-keV range of energies admits of a general analytic solution for the electron spectrum in terms of the x-ray spectrum, in a form convenient for computation. The bearing of this analysis on different models of flare conditions is considered. In examining the hypothesis that the x rays are produced in regions of high ambient density, the duration of the burst being governed by modulation of the electron source rather than by the decay of trapped electrons injected impulsively, it is emphasized that the energy spectrum of the electrons at their source is different from their effective spectrum in the x-ray emitting region. This spectrum, at the source, is found to be much steeper than that in the x-ray region which means that the entire energy of the flare could reside in the injected electrons. (auth)

49679 ANOMALOUS DISTRIBUTION IN HELIOCENTRIC LONGITUDE OF SOLAR-INJECTED COSMIC RADIATION. Keath, E. P.; Bukata, R. P.; McCracken, K. G.; Rao, U. R. (Univ. of Texas, Dallas). Solar Phys.; 18: No. 3, 503-9(Jul 1971).

Concurrent observations of the solar flare of March 12, 1969 by two spacecraft separated in solar longitude by 38° show that the accessibility at 1 AU to cosmic-ray particles is not a simple function of the relative solar longitude. The cosmic-ray flux, degree of anisotropy, and rise time all indicate that the favored path for cosmic-ray propagation in this event was some 40° to the east of the nominal Archimedes spiral line of force from the flare location. This is interpreted as evidence for either (a) extreme stochastical wandering of the lines of force of the interplanetary magnetic field, or (b) the redistribution of the cosmic rays in coronal magnetic fields prior to escape onto the nominal Archimedes spiral lines of force. (auth)

Galaxies

49680 SUPERNOVAE REMNANTS IN MAFFEI 1. Richter, G. M. (Zentralinstitut fuer Astrophysik, Babelsberg, Ger.). Nature (London) Phys. Sci.; 232: No. 29, 58-9(19 Jul 1971).

It is stated that there are three radio sources in the field around Maffei 1: 3C 69 and two other sources, here designated as 01 and 02. Assuming the latter sources as belonging to a galaxy 1 Mpc away, they have radio luminosities of the order of the supernova remnant Cas A, and an evaluation is made of the probability of 01 and 02 being supernovae remnants. Data are given for the properties of 01 and 02, assuming 1 Mpc, compared with other radio sources, and for their flux densities compared with background. It appears that the probability of 01 being a supernova remnant is of the order of a factor of 10 larger than the probability of it being a background source; for 02, however, this factor is only 2. Data for the upper limit of radio emission from Maffei 1 are also discussed. (UK)

49681 SEARCH FOR ISOLATED RADIO PULSES FROM THE GALACTIC CENTRE AT 151.5 MHz. Charman, W. N. (Atomic Energy Research Establishment, Harwell, Eng.). Nature (London); 232: No. 5307, 177-8(16 Jul 1971).

An extension of the authors' previous work (Nature, 228: 346(1970)) is reported, including a search for pulses from the galactic center (GC) which might be correlated with the gravitational events reported by Weber (Phys. Rev. Letters, 22: 1320(1969) and 25: 180(1970)). In order to discriminate against local interference, pulses received simultaneously by widely spaced receivers were looked for. Although the results were negative, they allowed upper limits to be placed on the radio energy emitted in pulses from the GC. Four working groups participated, with receivers at Cambridge, Dublin, Glasgow, Harwell, and Malta, and all stations operated at frequencies close to 151 MHz, with bandwidths between 0.2 and 1.0 MHz. The observing period was May 1 to Aug. 16, 1970, and the records of the individual sites were scanned for pulses that arrived in coincidence at two or more sites. Results are tabulated and discussed. The findings do not invalidate Weber's results, but show that there are no radio pulses from the GC at rates comparable with his rate of detection of gravitational events. (UK)

49682 KINEMATICS OF THE NEARBY STARS. I. THE VERTEX DEVIATION OF THE VELOCITY ELLIPSOIDS. Yuan, C. (City Coll., New York). Astron. J.; 76: No. 7, 664-(Sep 1971).

A statistical approach was adopted to construct theoretical space velocity distributions for the nearby stars using the density-wave theory of galactic spirals. The idea that the observed vertex deviation of nearby young stars is due to the places of origin was studied in great detail. It is shown that the synthesized space velocity distributions are in good agreement with observations. The theoretical spiral pattern as well as the pattern speed and the strength of the spiral gravitational field determined in previous studies was reaffirmed in the present analysis. (auth)

49683 GENERATION OF MAGNETIC FIELDS IN ASTROPHYSICAL BODIES. VII. THE INTERNAL SMALL-SCALE FIELDS. Lerche, I.; Parker, E. N. (Univ. of Chicago). Astrophys. J.; 168: No. 2, 231-7(1 Sep 1971).

The paper investigates the small-scale magnetic fields δB generated, along with the large-scale magnetic fields B, by cyclonic turbulence and large-scale shear. The results are directly applicable to the problem of the generation of magnetic fields in the Galaxy, for which the observations show only the complexity of the small- and large-scale fields together, making it difficult to discover the actual configuration of the large-scale galactic field. The calculations show that the local fluctuations in the generation of field in the Galaxy contribute a $\langle(\delta B)^2\rangle$ comparable to $\langle B^2\rangle$. (auth)

49684 GENERATION OF MAGNETIC FIELDS IN ASTROPHYSICAL BODIES. VIII. DYNAMICAL CONSIDERATIONS. Parker, E. N. (Univ. of Chicago). Astrophys. J.; 168: No. 2, 239-49 (1 Sep 1971).

It is pointed out that the kinetic energy of the differential rotation of the Galaxy is sufficient to maintain generation of the galactic magnetic field for a period of time in excess of 10^{10} years. In the Sun, on the other hand, the nonuniform rotation must be driven by thermal convective forces, etc. Magnetic buoyancy of the azimuthal field B_ϕ is an important energy source in the Sun, and contributes to the generation of the poloidal component of the solar field. In the Galaxy the magnetic buoyancy of B_ϕ contributes to the generation of the poloidal field, but if present observational estimates are correct, the inflation of the gaseous disk of the Galaxy by cosmic rays is a major source of the energy generating the poloidal component of the galactic poloidal field. The dynamical-dynamo equations are solved in the linear approximation to illustrate the direct generation of poloidal field from magnetic buoyancy and from cosmic-ray inflation. (auth)

49685 PROPAGATION OF HYDROMAGNETIC WAVES IN A STOCHASTIC MAGNETIC FIELD. Valley, George C. (Univ. of Chicago). Astrophys. J.; 168: No. 2, 251-64(1 Sep 1971).

The propagation of coherent small-amplitude hydromagnetic waves through a medium in which the magnetic field has a large-scale ordered component and a stationary random component was investigated. By neglecting third-order correlations between the random part of the wave and the stochastic field, dispersion relations which give the wavenumber as a function of frequency for the coherent part of the wave were obtained. From these dispersion relations, damping decrements were evaluated in several limits for the Alfvén mode propagating parallel to the average field and for the fast magnetosonic mode propagating perpendicular to the average field. In typical astrophysical systems these modes damp in 10 to 100 correlation lengths in a stochastic field; and since all other modes, and these modes at all other angles, undergo Landau damping, application to the solar wind and interstellar gas shows that no coherent hydromagnetic wave can propagate across the solar system or the Galaxy. (auth)

Cosmology

49686 (AD–715348) EFFECT OF COSMOLOGICAL EXPANSION ON SELF-GRAVITATING ENSEMBLES OF PARTICLES. Noerdlinger, Peter D.; Petrosian, Vahe (Stanford Univ., Calif. Inst. for Plasma Research. National Aeronautics and Space Administration, Moffett Field, Calif. Ames Research Center). 1 Dec 1970. Contract N00014-67-A-0112-0006. 23p. (SU-IPR-398). NTIS.

The authors consider the possible expansion of clusters or superclusters of galaxies, of mean rest mass density ρ_c, immersed in a cosmos containing a gas of particles having zero rest mass and having energy density $\rho(c^2)$. The cosmos may also contain dust. It is shown that when $\rho > \rho_c$, the clusters of superclusters, respectively, expand with the Universe, but if $\rho_c \gg \rho$, the expansion is reduced in the ratio ρ/ρ_c. It therefore seems unlikely that clusters of galaxies could have formed

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if the present value of ρ exceeds 10^{29} gm/cm^3, unless most of this radiation was generated outside the clusters and subsequent to their formation. Superclusters, if they exist, will follow the expansion of a universe of even lower energy density. (auth) (USGRDR)

49687 (CONF-690732, pp 6.1-8) TRAPDOOR PARADOX IN RELATIVITY. Price, H. E. (University of the Witwatersrand, Johannesburg (South Africa). Dept. of Physics).

From 4. seminar on theoretical physics; Johannesburg, South Africa (7 Jul 1969).

This has been introduced into the literature previously under the title "Length Contraction Paradox". A rod is moving fast across a table. In its path there is a pit into which, at rest, it could fit. From the rod's point of view the pit has contracted and is too small. The pit, on the other hand, thinks that the rod has shrunk and will easily fall in. The resolution of this problem is restated and taken further: the subsequent motion is described after the nose of the rod strikes the far wall of the pit. The situation is studied in the two cases of a soft rod and a soft wall. (auth)

49688 (CONF-690732, pp 7.1-16) NEW INTERPRETATION OF INTERVAL IN RELATIVITY WITH APPLICATIONS IN ASTRONOMY. Kaniuk, G. (University of the Witwatersrand, Johannesburg (South Africa)).

From 4. seminar on theoretical physics; Johannesburg, South Africa (7 Jul 1969).

An interpretation of the interval in special relativity is considered, i.e., it is a new way of looking at the interval even though there are no essentially new results presented. Possible applications in astronomy are mentioned. (W.D.M.)

49689 (CONF-690732, pp 9.1-2) SOLOMON–PRICE–EINSTEIN–KANIUK COSMOLOGY. (University of the Witwatersrand, Johannesburg (South Africa)).

From 4. seminar on theoretical physics; Johannesburg, South Africa (7 Jul 1969).

A flat 4-dimensional space containing initially a bland, homogeneous medium is considered. At the instant of creation a disturbance starts somewhere in this medium and propagates outward in the form of a spherical wave. This hypersurface is conjectured to the present Universe. (W.D.M.)

49690 GENERALIZED REDSHIFT–MAGNITUDE FORMULA. Kaufman, Sheldon E.; Schucking, E. L. (New York Univ., N. Y.). Astron. J.; 76: No. 7, 583-7(Sep 1971).

A closed formula for the relation between luminosity and redshift in an expanding Friedman universe was derived for the case of a positive cosmological constant, positive space curvature, and vanishing pressure. (auth)

49691 GENERAL RELATIVITY AND THE ORBIT OF ICARUS. Shapiro, Irwin I. (Massachusetts Inst. of Tech., Cambridge); Smith, William B.; Ash, Michael E.; Herrick, Samuel. Astron. J.; 76: No. 7, 588-606(Sep 1971).

Results from 413 photographic observations of the minor planet (1566) Icarus, including 342 from the 1968 close approach, were analyzed to improve the determination of Icarus' orbit and to test its consistency with the theory of general relativity. Introducing a parameter λ which would assume the value unity were general relativity correct and zero were Newtonian theory valid, $\lambda = 0.95 \pm 0.08$. (The uncertainty given is the formal standard error when that for each observation is assumed to be one arc second.) The value obtained for λ is, however, influenced significantly by the model employed to counteract inadequacies in the astrographic catalogues used in the reductions of the photographic plates. Corresponding sensitivity studies indicate that, on the basis of Icarus data alone, the real uncertainty in λ is about 0.2. If the relevant stellar positions are ever improved commensurate with the intrinsic accuracy of the location of Icarus with respect to them, the value of λ determined from the Icarus observations through 1968 will have an uncertainty of only about 0.05 provided also that the contributions of the solar quadrupole moment are either known or negligible. The Icarus data, predicted previously, are of marginal use for the determination of the solar quadrupole moment and cannot be used to improve estimates of other astronomical constants such as the mass of Mercury whose uncertainty on the basis of the Icarus data alone is about 500,000 (in terms of inverse solar masses), i.e., more than 20 times greater than the uncertainty deduced from prior analyses of radar data. (auth)

49692 ENTROPY GENERATION AND SURVIVAL OF PROTOGALAXIES IN AN EXPANDING UNIVERSE. Weinberg, Steven (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 168: No. 2, 175-94(1 Sep 1971).

General formulae were derived for the bulk viscosity, shear viscosity, and heat transport due to radiation, and for the damping rate of sound waves, in an imperfect relativistic fluid. These results were used to evaluate the cosmological entropy production associated with a nonvanishing mean free time of photons, neutrinos, or gravitons, and to calculate the rate of damping of protogalactic fluctuations in the period immediately prior to the recombination of hydrogen. (auth)

49693 EVOLUTION OF A RADIO SOURCE POPULATION. Edwards, D. (Univ. of Liverpool). Nature (London) Phys. Sci.; 232: No. 29, 59-60(19 Jul 1971).

An alleged error in the argument presented by Doroshkevich, Longair, and Zeldovich (Mon. Notic. Roy. Astron. Soc., 147: 139(1970)) is pointed out; these authors asserted that the two forms of evolution of a radio source population, usually referred to as density and luminosity evolution, are in principle equivalent. A reply by Longair is also given. (UK)

49694 SOURCES AND SINKS OF UNIVERSAL STRONG FIELDS (HEURISTIC CONSIDERATIONS IN COSMOLOGY). Ertel, H.; Treder, H.-J. (Zentralinstitut fuer Astrophysik, Potsdam, Ger.). Ann. Phys. (Leipzig); 26: No. 1, 23-8(1971). (In German).

In the Newtonian theory of gravitation only negative sources of gravity are existent. However, for an infinite universe with a mean density of matter $\bar{\rho} \neq 0$, consistent states are only possible if the mean densities of positive and negative sources are balanced. General relativistic cosmology gives possibilities for physical interpretations of the positive sources. (auth)

Planetary Phenomena

49695 CHARGED-PARTICLE-INDUCED IONIZATION RATES IN PLANETARY ATMOSPHERES. Dubach, J.; Barker, W. A. (Univ. of Santa Clara, Calif.). J. Atmos. Terrest. Phys.; 33: No. 8, 1287-8(Aug 1971).

A nonrelativistic formula for calculating the rate at which charged particles from a solar flare produce ion pairs in planetary atmospheres is derived. The method is simpler to use than the elaborate expression developed by Velinov 1968. (auth) (UK)

49696 PLASMA DENSITIES IN THE JOVIAN MAGNETOSPHERE: PLASMA SLINGSHOT OR MAXWELL DEMON? Ioannidis, G.; Brice, N. (Cornell Univ., Ithaca, N. Y.). Icarus; 14: No. 3, 360-73(Jun 1971).

The plasma-density distribution in the Earth's magnetosphere is described and the principal factors producing this distribution are discussed. These are diffusion of the ionospheric thermal plasma inside the plasmapause and ejection of terrestrial plasma and injection of solar-wind plasma beyond the plasmapause. For Jupiter, the ionospheric thermal plasma cannot escape into the magnetosphere and the density distribution is dominated by diffusion of photoelectrons at low L values, and interchange instabilities at larger distances (beyond about 8 R_j). These cause ejection of Jovian plasma from the body of the magnetosphere and injection of solar-wind plasma. The latter is a probable source of the energetic electrons needed to produce the decimetric emission. (auth)

49697 PRELIMINARY EXAMINATION OF LUNAR SAMPLES FROM APOLLO 14. Science; 173: No. 3998, 681-93(20 Aug 1971).

The nine major findings of the preliminary examination of the lunar samples including physical, chemical, mineralogical, and biological analyses are given. (W.D.M.)

Atomic and Molecular Physics

Refer also to abstracts 48904 and 50276.

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 49051, 50390, and 50804.

49698 ATOMIC BEAM POLARIZED $^3He^+$ ION SOURCE. Vyse, Robert Norman. Vancouver, British Columbia; Univ. of British Columbia (1970). National Library of Canada, Ottawa (1970).

Thesis.

A beam of polarized $^3He^+$ ions was produced using atomic-beam techniques. This method is capable of producing an ion beam with polarizations up to 100%. The polarization of ^3He beams presently

produced by optical pumping techniques is of the order of 5%. The apparatus is composed of three main sections: the atomic-beam source consisting of a supersonic nozzle cooled to liquid helium temperatures to produce a low-velocity atomic beam, the tapered hexapole magnet to spatially separate the particles in the two magnetic spin substates, and the electron bombardment ionizer to produce $^3He^+$ ions from the neutral ^3He atomic beam. The low-velocity beam is required because the nuclear magnetic moment of ^3He is of the order of 2000 times smaller than the electronic magnetic moment used to separate beams in conventional Stern–Gerlach magnets and to achieve a high ionization efficiency. The measured intensity of the beam produced by the atomic beam source cooled to liquid helium temperature was 1×10^{18} atoms/sterad sec, the most probable velocity was 310 m/sec, and the velocity full width at half maximum was 50 m/sec. The beam flux through the ionizer increases by a factor of 1.3 when the hexapole field is turned on, in good agreement with the theoretically expected increase. This increase corresponds to a polarization of 65% of the atomic beam. A 12-nA $^3He^+$ ion beam was obtained corresponding to an ionization efficiency of approximately 0.15%. (Diss. Abstr. Int., B)

49699 ENERGY LOSSES OF FAST ELECTRONS IN SOLID Ar, Ne, AND H_2. Schmidt, L. (Technische Univ., Berlin). Phys. Lett.; 36A: No. 2, 87-8(16 Aug 1971).

Energy losses of 37-keV electrons in solid Ar, Ne, and H_2 are measured with a resolution better than 0.08 eV. These spectra are compared with optical results. (auth)

49700 TEMPERATURE DEPENDENCES OF THE SECONDARY ION–ELECTRON EMISSION OF Au AND Cu SINGLE CRYSTALS DURING BOMBARDMENT BY ARGON IONS. Kapusta, O. I.; Lebedev, S. Ya.; Omel'yanovskaya, N. M.; Odintsov, D. D. Sov. Phys.-Solid State (Engl. Transl.); 13: No. 2, 301-4(Aug 1971).

Translated from Fiz. Tverd. Tela; 13: No. 2, 368-72(Feb 1971).

An experimental study was made of the effect of the target temperature on the angular dependences of the ion–electron emission of Cu and Au single crystals bombarded by argon ions. The Au temperature dependences are shown to have several features not observed previously. A qualitative analysis of the temperature dependences on the basis of transparency theory shows that these features are due to an important difference between the radii of the cross sections for displacing collisions and the screening radii for the $Au-Ar^+$ pair. (auth)

49701 ANISOTROPY IN THE ANGULAR DISTRIBUTION OF ION–ELECTRON EMISSION FROM A NIOBIUM SINGLE CRYSTAL. Begrambekov, L. B.; Kurnaev, V. A.; Sotnikov, V. M.; Tel'kovskii, V. G. (Moscow Engineering-Physics Inst.). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 2, 379-80(Aug 1971).

Translated from Fiz. Tverd. Tela; 13: No. 2, 471-3(Feb 1971).

A retarding potential was used with a Faraday cylinder moving in the $(10\bar{1})$ plane to measure the angular distributions for electrons with energies of 5 to 6, 10 to 12, 16 to 20, and 30 to 35 eV emitted by a (111) surface of a Nb single crystal in response to 25-keV Ar ions. These distributions have a fine structure, which is ascribed to preferential motion in the crystal along close-packed directions; this gives the energy dependence of the refractive index at the vacuum interface, which explains the peaks in the angular distribution of the total secondary current. Energetic electrons should make a substantial contribution to the peaks in the total emission. It is considered that the angular and energy trends are related to the dispersion law for electrons in the free band. (auth)

49702 MULTIPLE SCATTERING OF HEAVY IONS OF keV ENERGIES TRANSMITTED THROUGH THIN CARBON FILMS. Andersen, H. H.; Boettiger, J. (Univ. of Aarhus, Denmark). Phys. Rev., B; 4: No. 7, 2105-10(1 Oct 1971).

Experimental studies are described of multiple scattering of 13 different heavy ions with $3 \leq Z_1 \leq 30$ in the energy range of 200 to 1000 keV, transmitted through thin (8 to 25 $\mu g/cm^2$) carbon foils. The agreement between the experimental data, recent theoretical calculations, and published experimental data is found to be satisfactory, although a small systematic deviation exists for thicker foils. (auth)

49703 THE K_α/K_β X-RAY INTENSITY RATIOS FOR $57 \leq Z \leq 70$ FROM ELECTRON BOMBARDMENT. Mistry, V. D.; Quarles, C. A. (Texas Christian Univ., Fort Worth). Phys. Lett.; 36A: No. 3, 221-2(30 Aug 1971).

K_α/K_β x-ray intensity ratios were measured using a Ge(Li) x-ray detector by bombarding thin oxide targets of nine rare earth elements with an electron beam of energy up to 140 keV. (auth)

49704 ELASTIC ELECTRON–ATOM SCATTERING AT INTERMEDIATE ENERGIES. Joachain, C. J. (Univ. Libre, Brussels); Mittleman, M. H. Phys. Lett.; 36A: No. 3, 209-10(30 Aug 1971).

An eikonal theory, based on the optical model formalism, is proposed for electron–atom scattering at intermediate energies. Detailed calculations are performed for electron–helium scattering in the range 100 to 500 eV. The results are in good agreement with recent experimental data. (auth)

49705 IDENTIFICATION OF CHARACTERISTIC ENERGY LOSSES ON SCATTERING OF FAST ELECTRONS AT LARGE ANGLES. Rumyantsev, V. V. (Polytechnic Inst., Leningrad). Phys. Lett.; 36A: No. 3, 213-14(30 Aug 1971).

The theoretical rule for the determination of the nature of the characteristic energy losses by backscattering electrons is proposed. This rule is based on the different types of the dependence of the characteristic peak height on the energy of electrons. (auth)

49706 EXCITATION OF HYDROGEN ATOMS BY PROTON IMPACT. Tripathi, A. N.; Mathur, K. C.; Joshi, S. K. (Univ. of Roorkee, India). Phys. Lett.; 36A: No. 3, 161-2(30 Aug 1971).

The Glauber approximation was applied to the excitation of the (1s–2s) and (1s–2p) transition of hydrogen by proton impact. The integrated excitation cross sections calculated by Glauber theory were compared with other calculations. (auth)

49707 ELECTRON LOSS FROM HYDROGEN ATOMS INCIDENT ON MOLECULAR HYDROGEN, NITROGEN, AND OXYGEN. Mathur, K. C.; Tripathi, A. N.; Joshi, S. K. (Univ. of Roorkee, India). Phys. Lett.; 36A: No. 3, 189-90(30 Aug 1971).

The electron-loss cross-sections for hydrogen atoms incident on H_2, N_2, and O_2 molecules were calculated using the free scattering model and the Born approximation. The phase difference between the electrons scattered from the two atoms of the molecule was considered. The results are compared with the available data. (auth)

49708 DIRECT OBSERVATION OF MULTIPLE L-SHELL VACANCY EFFECTS IN ENERGETIC HEAVY-ION COLLISIONS. Der, R. C.; Fortner, R. J.; Kavanagh, T. M.; Khan, J. M. (Univ. of California, Livermore). Phys. Lett.; 36A: No. 3, 239-40(30 Aug 1971).

Observations were made of soft L x-ray spectra resulting from collisions of 8- to 20-MeV oxygen ions and Ni, Cu and Zn atoms. These observations provide confirmation of the multiple L-shell vacancies proposed to explain recent experimental determinations of K-shell x-ray energy shifts in such collisions. The energy dependence of the single vacancy shifts indicates that the probability of outer-shell ionization is a decreasing function of ion energy in this energy range. (auth)

49709 ENERGY DISTRIBUTION OF AUGER ELECTRONS EMITTED BY LIGHT METALS UNDER ION BOMBARDMENT. Hennequin, Jean-Francois (Paris-Nord Univ., Saint-Denis, France); Viaris de Lesengno, Patrick. Compt. Rend., Ser. B; 272: No. 22, 1259-62(2 Jun 1971). (In French).

A 180° magnetic analyzer was used to study the energy distribution of the secondary electrons emitted by light metals (Be, Mg, Al, and Si) bombarded with 10-keV Ar^+ ions. The region around the peaks due to electrons emitted in the de-excitation of metal atoms near to surface by the Auger effect was of particular interest. (auth) (France)

49710 PROJECTILE CHARGE DEPENDENCE OF K-SHELL IONIZATION BY SWIFT LIGHT NUCLEI. Basbas, George (New York, Univ., N. Y.); Brandt, Werner; Laubert, Roman; Ratkowski, Anthony; Schwarzschild, Arthur. Phys. Rev. Lett.; 27: No. 4, 171-4(26 Jul 1971).

K-shell x-ray yields were measured for Al and Ni bombarded by H, D, He, and Li of kinetic energies between 1 and 7.5 MeV/amu. Ratios of K-shell ionization cross sections for projectiles of different atomic numbers Z_1, at equal velocities, show pronounced deviations from the Z_1^2 dependence predicted in the plane-wave Born approximation. The effect can be understood in terms of distortions of the K shell in the field of the ionizing particles. (auth)

49711 DIFFERENTIAL CROSS SECTIONS FOR K-SHELL IONIZATION OF SURFACE ATOMS BY ELECTRON IMPACT. Gerlach, Robert L.; DuCharme, A. R. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev. Lett.; 27: No. 6, 290-3(9 Aug 1971).

Differential cross-section measurements for inner-shell ioniza-

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tion of surface atoms by electron impact are reported for C, N, and O adsorbed on W. Comparison is made with calculations derived from a simple extension of the Burhop theory for ionization of isolated atoms. The trends of the predicted values are in qualitative agreement with experiment. (auth)

49712 INVESTIGATION OF EXOELECTRON EMISSION FROM ELECTRON-IRRADIATED METALS. Schlenk, W.; Huster, E. (Univ., Muenster, Ger.). Z. Phys.; 246: No. 1, 43-59(1971). (In German).

The exoelectron emission from electron-irradiated metal specimens was measured in a heatable Geiger–Mueller counter. For a silver specimen, the term data (activation energy, frequency factor) of the traps were determined from the shape of the glow curve, using the methods applied on thermoluminescence glow curves. The comparison of the glow curve with theoretical emission curves of monoenergetic traps showed that the glow curve consisted of several emission curves, which had not been resolved in the measurement. For the activation energies of the traps responsible for the emission in the temperature range from 20 to 180°C, values of about 1 eV were obtained. The computed frequency factors are rather uncertain; they cover the range between 10^9 and 10^{14} sec^{-1}. (auth)

49713 NEW TYPE OF dc ION SOURCE. Majumdar, N. K. (Saha Inst. of Nuclear Physics, Calcutta). pp 296-300 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

Atomic and Molecular Properties

Refer also to abstracts 49609 and 50003.

49714 (NYO-1447-70) SPECTRA OF RARE EARTH AND URANIUM IONS. Annual Report No. 21. Judd, B. R.; Crosswhite, H. M. (Johns Hopkins Univ., Baltimore, Md.). 30 Jun 1971. Contract AT(30-1)-1447. 7p. Dep. NTIS.

A summary of the work done is presented. It deals with the following topics: theoretical spectroscopy, matrix elements and parameters for f-shell calculations, uranium crystal spectra, and H_2 and OT wavelength tables. (auth)

49715 PROPERTIES OF A DISCRETE SPECTRUM FOR VALUES OF Z CLOSE TO 137. Popov, V. S. ((Inst. of Theoretical and Experimental Physics, Moscow). Zh. Eksp. Teor. Fiz.; 60: No. 4, 1228-44(Apr 1971). (In Russian).

The nature of the discrete spectrum for an electron in the Coulomb field of a bare nucleus of charge close to 137 is investigated. In this region of Z values the level spectrum significantly depends on cutoff of the Coulomb potential at small distances. An equation is derived for the level energies ϵ_n. In the logarithmic approximation (i.e., on the condition that $L = \ln(\hbar/mcR) \gg 1$, where m is the electron mass and R is the nuclear radius), the equation can be obtained for ϵ_n. (auth)

49716 ZERO-FIELD LEVEL CROSSING IN MOLECULAR HYDROGEN. Vander Linde, Jacob. Vancouver, British Columbia; Univ. of British Columbia (1970). National Library of Canada, Ottawa).

Thesis.

The lifetimes of the $3d^1\Sigma(v = 0)$ J = 1, 2, and 3 states were measured using zero-field level-crossing techniques. The transitions observed were the R-branch members of the $3d^1\Sigma \rightarrow 2p^1\Sigma$ transition. The upper state is excited in a discharge between two capacitor plates to which a radio-frequency voltage is applied. The measurements were made using first a 180-MHz rf source and later a 450-MHz source. The depolarization curves obtained by plotting the magnetic field strength against the polarization of the R(0), R(1), R(2) lines yield halfwidths, when extrapolated to zero pressure, of 2.37 ± .12, 2.60 ± .15, and 3.25 ± .25 gauss. The halfwidths vary linearly with pressure in the discharge cell yielding collision cross sections of roughly 1.5×10^{-14} cm^2. Using the high-field Landé g values of these states, their lifetimes are $(2.66 \pm .12) \times 10^{-8}$, $(3.83 \pm .2) \times 10^{-8}$, and $(3.93 \pm .25) \times 10^{-8}$ sec for J = 1, 2, and 3, respectively. The discrepancy between the first and the latter two lifetimes is discussed. (Diss. Abstr. Int., B)

49717 OBSERVATION OF THE STARK EFFECT IN THE 4,5 AND 6^1D_2 LEVELS OF ^{3}He. APPLICATION TO THE DETERMINATION OF THEIR HYPERFINE STRUCTURE SIGN. Dily, Daniel; Descoubes, Jean-Pierre (Ecole Normale Superieure, Paris). Compt. Rend., Ser. B; 272: No. 19, 1135-8(10 May 1971). (In French).

The level-crossing method was used to study the Stark effect in the n^1D_2 levels of ^{3}He excited by transverse electron bombardment. When an electric field is applied, the sign of the hyperfine structure constant is given by the direction of the variation of the crossing fields. (auth) (France)

49718 AUGER ELECTRONS: THEORY AND EXPERIMENTS. EXPERIMENTAL DETERMINATION OF DOUBLETS FOR Z = 92. Briancon, Chantal (CNRS, Orsay, France). Ann. Phys. (Paris); 5: No. 2, 151-68(Mar–Apr 1970). (In French).

A survey is given of the theory of the emission of KLL Auger electrons, in several coupling approximations, in order to show the relative importance of Z in the electrostatic interaction and the spin–orbit coupling. The analysis of experimental results indicates the need for more data at high Z values where the doublets are good tests of the intermediate-coupling hypothesis as well as the validity of the extrapolations used. It is for this reason that the Auger KLL spectrum emitted after $^{233}Pa \xrightarrow{\beta} {}^{233}U$ disintegration was studied at high resolution, resolving the KL_1L_2 and KL_1L_3 doublets. (auth) (France)

49719 SUPERPOSITION OF THE WAVE FUNCTIONS CENTERED ON THE NUCLEI AND THE FLOATING WAVE FUNCTIONS FOR THE GROUND STATE OF THE HYDROGEN MOLECULES. Adamov, M. N.; Evarestov, R. A. (Leningrad State Univ.). Chem. Phys. Lett.; 9: No. 5, 465-6(1 Jun 1971).

It is shown that the superposition of wave functions centered on the nuclei and floating wave functions represents the distribution of the electronic charge along the molecular axis in the ground state of the hydrogen molecule more accurately than either of these two functions separately. The mean-square values of electronic coordinates are calculated. (auth)

49720 THEORETICAL TREATMENT OF THE ENERGY DIFFERENCES BETWEEN $f^qd^1s^2$ AND $f^{q+1}s^2$ ELECTRON CONFIGURATIONS FOR LANTHANIDE AND ACTINIDE ATOMIC VAPORS. Nugent, L. J.; Vander Sluis, K. L. (Oak Ridge National Lab., Tenn). J. Opt. Soc. Amer.; 61: No. 8, 1112-15(Aug 1971).

The differences between the lowest energy level of the $f^qd^1s^2$ electron configuration and the lowest energy level of the $f^{q+1}s^2$ electron configuration for the metal vapors of nine members of the lanthanide series and four members of the actinide series are shown to be neatly and simply correlated by an adaptation of Jørgensen's refined electron-spin-pairing energy theory. The theory is also used to extrapolate the corresponding energy differences for those lanthanide and actinide metal vapors for which this information was previously undertermined. The results will be helpful as a guide in making spectral assignments, and they are generally useful in correlating the thermodynamic properties of the chemical compounds of the lanthanide and actinide series. The theoretical basis of the treatment should also be applicable for correlating the relative energies of other electron configurations in these metal atoms and ions. (auth)

49721 ENERGIES OF THE ELECTRONIC CONFIGURATIONS OF THE LANTHANIDE AND ACTINIDE NEUTRAL ATOMS. Brewer, Leo (Univ. of California, Berkeley). J. Opt. Soc. Amer.; 61: No. 8, 1101-11(Aug 1971).

The thermodynamic data for the lanthanide and actinide metals were combined with spectroscopic data to develop a method of estimating the energies of the electronic configurations of the neutral gaseous atoms. Energies are tabulated for the lowest spectroscopic level of each configuration. Many of the odd terms of La I were reclassified. (auth)

49722 DETERMINATION OF INTERACTION ENERGY OF ISOTOPES OF ATOMIC HYDROGEN WITH MEDIA. Urbanovich, S. I. Zh. Prikl. Spektrosk.; 13: No. 3, 560-2(Sep 1970). (In Russian).

The energies of the interactions of the isotopes of hydrogen (^{1}H, ^{2}H, and ^{3}H) and also of muonium and positronium with the surrounding gas are calculated on the basis of the displacement of levels of the hyperfine structure in the medium in comparison with vacuum. Expressions are obtained for the energy of interaction between separate atoms and for the medium as a whole. (tr-auth)

49723 LIFETIME MEASUREMENTS OF AUTOIONIZING LEVELS BY THE BEAM–FOIL TECHNIQUE. Berry, H. G.; Desesquelles, J.; Dufay, M. (Univ. Claude Bernard, Lyon. Laboratoire de Physique de l'Atomosphere, Villeurbanne, France). Phys. Lett.; 36A: No. 3, 237-8(30 Aug 1971).

Natural linewidths were measured in doubly excited He I and

Li I. They yield lifetimes of $(7.5 \pm 1.0) \times 10^{-14}$ sec for 1s $(2s2p^1P)$ ^2P in Li I and $(1.4 \pm 0.2) \times 10^{-13}$ sec for $2s^2\ ^1S$ in He I. (auth)

49724 APPLICATION OF THE LEVEL CROSSOVER METHOD TO THE MEASUREMENT OF THE LEVEL STRUCTURE OF THE ^{4}He AND ^{23}Na ATOMS EXCITED BY ELECTRON BOMBARDMENT. Dily, Daniel; Descoubes, Jean-Pierre (Ecole Normale Superieure, Paris). Compt. Rend., Ser. B; 272: No. 20, 1182-4(17 May 1971). (In French).

The fine structure of the 5 ^{3}D and 6 ^{3}D states of the ^{4}He atom and the hyperfine structure of the 4 $^2P_{\frac{1}{2}}$ level of the ^{23}Na atom were determined from the observation of level crossovers. the excited states being obtained by transverse electron bombardment. (France)

49725 ELECTRIC QUADRUPOLE MOMENTS FOR H_2^+, H_2, AND H_3^+ FROM A POINT CHARGE MODEL. Borkman, R. F. (Georgia Inst. of Tech., Atlanta). Chem. Phys. Lett.; 9: No. 6, 624-6(15 Jun 1971).

Electric quadrupole moments calculated for H_2^+, H_2, and H_3^+ using a point-charge model are found to agree, with an average error of about 10%, with accurate values from the literature. The model uses bond lengths and vibrational stretching force constants as input and yields primitive molecular electronic structures as output. (auth)

49726 EXPERIMENTAL ATOMIC-ELECTRON BINDING ENERGIES IN FERMIUM. Porter, F. T.; Freedman, M. S. (Argonne National Lab., Ill.). Phys. Rev. Lett.; 27: No. 6, 293-7(9 Aug 1971).

Atomic electron binding energies for Fm were measured ($\pm$ ~10 eV) for shells K, L_{1-3}, N_{1-5}, $N_{6,7}$, O_{1-3}, $O_{4,5}$, and $P_{2,3}$ from conversion-electron spectroscopy in the β decay $^{254\,m}$Es $\rightarrow$ ^{254}Fm. The $P_{2,3}$ value of 24 $\pm$ 9 eV is unexpectedly low compared to empirical and to self-consistent-field-based extrapolations. Preferential judgements among published actinide binding-energy tabulations are presented. (auth)

49727 SEMI-EMPIRICAL FORMULA FOR K-SHELL PHOTOEFFECT IN INTERMEDIATE AND HIGH Z ATOMS. Hla, Yin Yin (Arts and Science Univ., Rangoon, India); Khaing, Chit; Su, May; Ghose, A. M. pp 70-5 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28-31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 49455, 50016, and 50020.

49728 (N-71-16053) 5g $\rightarrow$ 4f PIONIC TRANSITION IN ^{232}Th AND ^{238}U. Jenkins, D. A.; Powers, R. J.; Kunselman, A. R. (Virginia Polytechnic Inst., Blacksburg). [1970]. 16p. (NASA-CR-116140). NTIS.

Early measurements of pionic x-ray energies and widths in ^{232}Th and ^{238}U have suggested the possibility of an anomalous effect for the interaction between high-Z nuclei and a pion in the 4f atomic state. The 5g $\rightarrow$ 4f x-ray energies and widths were remeasured in these isotopes and compared to a calculation that considers the distortion of the nucleus. A small disagreement between theory and experiment persists, but it is probably due to uncertainties in the calculation of the strong interaction effects. (STAR)

49729 EIGENSTATES OF OPTICAL POTENTIALS FOR EXOTIC ATOMS. Koch, Justus H.; Sternheim, Morton M.; Walker, James F. (Univ. of Massachusetts, Amherst). Phys. Rev. Lett.; 26: No. 24, 1465-8(14 Jun 1971).

Variations of exotic-atom energy levels and widths with the strength of the nuclear interaction are explained with the aid of a soluble model. (auth)

49730 FAST DEPOLARIZATION OF POSITIVE MUONS IN SOLUTION: THE CHEMISTRY OF ATOMIC MUONIUM. Brewer, J. H. (Univ. of California, Berkeley); Crowe, K. M.; Johnson, R. F.; Schenck, A.; Williams, R. W. Phys. Rev. Lett.; 27: No. 6, 297-300(9 Aug 1971).

The initial magnitude and direction of the residual asymmetry in the decays of polarized positive muons stopped in solutions in transverse magnetic fields are observed to depend strongly upon the concentration of dissolved compounds. Such effects were seen in methanol solutions of I_2 and in aqueous solutions of $FeCl_3$ and $Fe(ClO_4)_3$. The underlying fast depolarization mechanism can be qualitatively and quantitatively understood by assuming muonium formation with subsequent chemical reaction of the atomic muonium with dissolved compounds. (auth)

Collision Phenomena

Refer also to abstracts 49621, 49894-49896, 50041, and 50281.

49731 (BNWL-SA-3793) ANGULAR DISTRIBUTIONS OF ELECTRONS EJECTED BY FAST PROTONS. Toburen, L. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1971]. Contract AT(45-1)-1830. 16p. (CONF-710702-2). Dep. NTIS.

From seventh international conference on the physics of electronic and atomic collisions; Amsterdam, Netherlands (26 Jul 1971).

Cross sections, differential in energy and angle, for electron ejection by 0.3- to 2.0-MeV protons on helium and hydrogen were measured. The results are compared with theoretical calculations based on the Born approximation, the binary-encounter theory, and the Faddeev equations. Possible explanations of the discrepancies encountered are considered. (A.G.W.)

49732 (CEA-CONF-1751) STUDY OF THE REACTIONS BETWEEN CH_n^+ IONS AND GASEOUS TARGETS IN THE ENERGY RANGE 40 TO 140 keV. Guidini, J.; Roussel, M.; Valckx, F.P.G. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1970. 10p. (In French). (CONF-710320-1). Dep. NTIS (U. S. Sales Only).

From fifth national conference on atom and electron collisions; Rennes, France (31 Mar 1971).

The cross sections of the following reactions between hydrocarbon ions and gaseous targets were measured: C^+ charge-exchange cross section; CH_n^+ splitting cross section in such reactions as: $CH_n^+ \rightarrow CH_{n-p}^+ + \ldots$; production cross section of hydrocarbon neutral particles from a CH_n^+ ion: $CH_n^+ \rightarrow CH_n$, or CH_{n-1}, or ..., or C; cross sections of such reactions as: $CH_n^+ \rightarrow CH_{n-p}^+ + qH$. The targets used were: H_2, D_2, N_2, He, Ne, Ar. (auth) (France)

49733 (CEA-CONF-1780) SCATTERING OF NEUTRAL PARTICLES BY A GASEOUS TARGET. Eliot, M.; Guidini, J.; Roussel, M.; Valckx, F. P. G. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1971. 15p. (In French). (CONF-710320-2). Dep. NTIS (U. S. Sales Only).

From National association of corrosion engineers high temperature symposium; Chicago, Ill. (22 Mar 1971).

The scattering of atom beams of 40 to 120 keV by a gaseous target (molecular hydrogen or rare gases) at a maximum angle of 6° in the lab. system was studied. The differential cross sections were calculated from a potential law. The Coulomb potential with screening effect and the potential of interaction between two atoms deduced from the Thomas-Fermi statistical model were used. The angular distributions of atoms involved in elastic collisions with a gaseous target were measured (the collisions are considered to be elastic when there is no charge exchange even though the particles may be excited). (auth) (France)

49734 (HMI-B-111) ELASTIC AND REACTIVE SCATTERING OF IONS ON MOLECULES. Henglein, A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). 1971. 45p. Dep. NTIS (U. S. Sales Only).

The more fundamental effects in ion-molecule interactions, such as potential functions, trajectory calculations, and elastic scattering phenomena, are considered. Rainbow scattering of ions is treated classically and quantum mechanically, and some results of experimental measurements are included. With regard to reactive scattering, the following topics are discussed: experimental procedures, Newton diagrams and intensity contour diagrams, spectator stripping and hard-sphere scattering, energy considerations and other impulsive reactions, and complex formation. (72 references) (A.G.W.)

49735 (ITF-71-14P) SLOW COLLISIONS IN THE SYSTEM OF THREE BODIES INTERACTING ACCORDING TO THE COULOMB LAW. Matveenko, A. V.; Ponomarev, L. I. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 60p. (In Russian). Dep. NTIS (U. S. Sales Only).

A general approach to the problem of scattering in a system of three bodies with Coulomb interaction is presented. This is essentially the method of perturbed stationary states. The method makes it possible to formulate and to solve some problems in atomic and mesoatomic physics. (auth)

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49736 (MLM-1841(TR)) EFFECTIVE COLLISION CROSS SECTIONS IN SCATTERING EXPERIMENTS. Berkling, K.; Helbing, R.; Kramer, K.; Pauly, H.; Schlier, C.; Toschek, P. Translated by W. L. Taylor (Mound Lab., Miamisburg, Ohio), from Z. Phys.; 166: 406-28(1962). 23p. Dep. NTIS.

Scattering experiments are often not performed with the ideal setup consisting of a monochromatic beam and target particles at rest. This is, for instance, never the case in molecular-beam scattering, which is of primary interest in this paper. Two arrangements are normally employed, one consisting of a gas chamber as target (case a), the other of crossed beams, generally at right angles (case b). In both cases the scattering particles have a Maxwellian velocity distribution. This means that in any such experiment an "effective cross section" is measured, which is an integral over cross sections for different collision velocities. Other similar integrals are needed if one works with polarized beams and takes into account the fact that the cross section is angle-dependent. A third type of integral is required when the primary beam is not monochromatized and one has to average over its velocity distribution too. The functions needed to interpret scattering experiments of all the types mentioned are given in this paper, as well as a table of values for the 24 most important of these functions. (auth)

49737 (N-71-20488) THEORETICAL RESEARCH: ELECTRONIC, IONIC, AND ATOMIC IMPACT PHENOMENA. Final Report. Smith, Felix T. (Stanford Research Inst., Menlo Park, Calif.). 31 Jan 1971. Contract NASr-49(07). 22p. (NASA-CR-117178; SU-32). NTIS.

The results are presented of a program aimed at developing, for some wide classes of collision problems, sufficient knowledge to generate simple and rapid methods for estimating cross sections and reaction rates needed for practical applications. The methods developed are applicable to several classes of reactions including: ion-ion neutralization, charge transfer at large distances, and optical or metastable excitation associated with charge transfer. The more general and formal aspects of collision theory are broadly considered along with specific applications of collision theory to specific scattering processes observed in the laboratory. Particular emphasis is placed on the analysis and interpretation of experimental results in the light of theoretical principles. (STAR)

49738 (ORO-2911-13) INTERACTION OF HEAVY keV IONS WITH GASES. Progress Report, June 1, 1970-May 31, 1971. Boring, John W. (Virginia Univ., Charlottesville. Research Labs. for the Engineering Sciences). Jun 1971. Contract AT(40-1)-2911. 25p. (AEEP-3930-108-71-U). Dep. NTIS.

Reduced differential scattering cross sections for He^+ + Ar, He^+ + He, H^+ + Kr, and H^+ + Ar are reported. Potentials that can be used to predict these results are considered. The ionization yield for 50-keV Ar^+ ions in an argon-acetylene mixture was measured for acetylene concentrations up to 1%. The yield at 0.1% acetylene was 55% greater than that for pure argon. A method of calculation of the cascade processes initiated by heavy ions is suggested; it explicitly follows the cascade through its succession of events. An attempt to calculate the average energy lost to electronic excitation in a collision at any velocity between an incident atom or ion and some target system as a function of impact parameter is described briefly. Comparison of results of this calculation for a proton incident on a hydrogen atom shows fairly good agreement. (A.G.W.)

49739 MEASUREMENT OF THE CREATION, SCATTERING, AND DESTRUCTION TERMS OF RARE-GAS METASTABLE ATOMS OF THERMAL ENERGY. Watel, Guy; Pesnelle, Annie (CEA, Saclay, France). Compt. Rend., Ser. B; 272: No. 13, 785-8(29 Mar 1971). (In French).

A new method was used for studying the collisional formation and destruction of rare gas metastable atoms of thermal energy. Values of the cross sections for formation of helium, neon, argon, and krypton metastable atoms by electron bombardment were obtained. Values of the coefficients for scattering and two-body destruction of helium, argon, and krypton metastable atoms are also given. (auth) (France)

49740 COLLISION-INDUCED DISSOCIATION OF 10-keV N_2^+ IONS: EVIDENCE FOR PREDISSOCIATION OF THE $C^2\Sigma_u^+$ STATE. Fournier, P.; Van de Runstraat, C. A.; Govers, T. R.; (and others) (FOM-Instituut voor Atoom- en Molecuufysica, Amsterdam). Chem. Phys. Lett.; 9: No. 5, 426-8(1 Jun 1971).

An analysis is made of the laboratory velocity distribution of forward and backward scattered N^+ fragments produced by the impact of a 10-keV N_2^+ beam on He. The discrete structure observed is ascribed to a collision-induced population of the $C^2\Sigma_u^+$ state of N_2^+, followed by a predissociation of its $v' \geq 3$ levels. The lifetime of the levels $v' \geq 4$ is estimated to be 5×10^{-9} sec; that for the $v' = 3$ is considerably longer. (auth)

49741 PURE ROTATIONAL EXCITATION IN CO^+-Ar INTERACTIONS BY ION-BEAM COLLISION SPECTROSCOPY. Moran, T. F.; Petty, F.; Turner, G. S. (Georgia Inst. of Tech., Atlanta). Chem. Phys. Lett.; 9: No. 5, 379-81(1 Jun 1971).

The energy-loss spectra observed in collisions of a CO^+ ion beam with a neutral Ar beam reveal inelastic processes occurring with an energy loss below that required for the $\nu = 0 \rightarrow 1$ vibrational transition. These inelastic events correspond to pure rotational excitation of the incident ion beam with a large change in rotational quantum number. (auth)

49742 ASYMMETRIC PEAKS IN ELECTRON SPECTRUM FOR H^+-He COLLISIONS. Bordenave-Montesquieu, A.; Benoit-Cattin, P. (Univ. Paul Sabatier, Toulouse). Phys. Lett.; 36A: No. 3, 243-4(30 Aug 1971).

Electrons resulting from decay of the autoionizing levels of helium were measured. Variations of the peak shape with angle of ejection (from 17° to 156° to the proton beam), and energy of the incident particle, were observed. (auth)

49743 CALCULATION OF EFFECTIVE CROSS SECTIONS FOR LOSS OF K ELECTRONS BY FAST HYDROGEN-LIKE IONS ON COLLISION WITH NITROGEN ATOMS. Senashenko, V. S.; Nikolaev, V. S.; Shafer, V. Yu.; Dmitriev, I. S. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 11: No. 2, 136-45(Mar-Apr 1970). (In Russian).

Cross sections for loss of K electrons by fast hydrogen-like ions of any element on collision with atoms of nitrogen were calculated by means of the nonrelativistic Born approximation. Simple approximate expressions for the cross sections in limited cases were obtained. (tr-auth)

49744 COLLISIONAL EXCITATION OF ROTATION FOR A THREE-DIMENSIONAL DIATOMIC OSCILLATOR. Eastes, W.; Secrest, D. (Univ. of Illinois, Urbana). Chem. Phys. Lett.; 9: No. 6, 508-9(15 Jun 1971).

S-matrix elements for rotational excitation were calculated in a close-coupling scheme that includes excited vibrational states. It was found that the rigid-rotor approximation is not entirely justified and that only near rotational states need be included. (auth)

49745 NONADIABATIC MODEL FOR POPULATION INVERSION IN MOLECULAR COLLISIONS. Hofacker, G. L. (Technische Hochschule, Munich); Levine, R. D. Chem. Phys. Lett.; 9: No. 6, 617-20(15 Jun 1971).

A mechanism for population inversion based on the dynamic displacement of the equilibrium position for internal motions is presented. The displacement is treated exactly using a van Vleck transformation, and the remaining nonadiabatic terms are handled in low-order perturbation theory. Criteria for population inversion are established. (auth)

49746 COLLISIONAL IONIZATION OF CESIUM BY OXYGEN: THE ELECTRON AFFINITY OF O_2. Nalley, S. J.; Compton, R. N. (Oak Ridge National Lab., Tenn.). Chem. Phys. Lett.; 9: No. 6, 529-33(15 Jun 1971).

The relative cross section for the production of O_2^- and O^- resulting from collisions of cesium and molecular oxygen was studied as a function of the incident cesium energy from $0 \approx 85$ eV. The energy distribution of the cesium beam is determined by a time-of-flight analysis. Accurate measurements of the threshold for the charge-exchange reaction yield a lower limit to the electron affinity for O_2 of 0.46 ± 0.05 eV. The low-energy tail of the charge-exchange cross section is quantitatively shown to be due to the Doppler motion of the target O_2 molecules. (auth)

49747 FINAL STATES IN THE DISSOCIATIVE EXCITATION OF MOLECULAR HYDROGEN. Misakian, Martin; Zorn, Jens C. (Univ. of Michigan, Ann Arbor). Phys. Rev. Lett.; 27: No. 4, 174-7(26 Jul 1971).

The dissociative excitation $H_2 + e \rightarrow H(2s) + H + e$ was studied by a time-of-flight method. Measurements of the excitation function and the angular distribution of the metastable atoms show that the slow atoms arise from dissociation of $e^3\Sigma_u^+$ and $B'\ ^1\Sigma_u^+$ states and from predissociation of the $d^3\Pi_u^+$ and $D^1\Pi_u^+$ states. The fast atoms arise from a previously unreported $^1\Pi_u$ state that corresponds to a separated-atom limit in which both atoms are in n = 2 states. (auth)

49748 ROTATIONAL EXCITATION IN Li^+-N_2 COLLISIONS. Lowe, R. P.; Ferguson, H. I. S. (Univ. of Western Ontario, London). Can. J. Phys.; 49: No. 12, 1680-4(15 Jun 1971).

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The population distribution in the rotational levels of the $B^2\Sigma_u^+$ state of N_2^+ produced in $Li^+ - N_2$ collisions was measured for incident Li^+ energies in the range 3 to 10 keV. Boltzmann distributions were found at all energies at rotational temperatures decreasing from 2500°K for 3-keV excitation to 960°K for 10 keV. This variation is shown to be consistent with a simple model of the conservation of angular momentum in the collision. (auth) (Canada)

49749 TEMPORARY FORMATION OF H_2^- ABOVE THE H_2^+ THRESHOLD BY ELECTRON IMPACT. Golden, D. E. (Univ. of Nebraska, Lincoln). Phys. Rev. Lett.; 27: No. 5, 227-30(2 Aug 1971).

The energy-differentiated electron-impact spectra of H_2 were studied near the H_2^+ threshold in a transmission experiment. Eleven structures with spacings characteristic of the $^2\Sigma_g$ state of H_2^- were found starting at about 13.6 eV. Five of these structures are above the H_2^+ threshold. It is suggested that some of the structure previously found in the cross section for the production of H_2^+ near threshold is due to autoionization of this state of H_2^-. (auth)

49750 ELECTRONIC CHARGE DISTRIBUTION IN HEAVY ATOMS FROM NON-RESONANT COHERENT SCATTERING CROSS SECTIONS. Roy, S. C.; Ghose, A. M. (Bose Inst., Calcutta). pp 65-9 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28-31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

49751 MEASUREMENT COHERENT SCATTERING CROSS-SECTIONS AT VERY LOW MOMENTUM TRANSFER. Nath, A. (Bose Inst., Calcutta). pp 76-80 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28-31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

49752 COMPTON SCATTERING BY K-SHELL ELECTRONS AT 1.12 MeV. Kane, P. P.; Prasad, P. N. Baba (Indian Inst. of Tech., Bombay). pp 81-3 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28-31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

49753 INELASTIC SCATTERING OF GAMMA RAYS BY K SHELL ELECTRONS. Reddy, D. V. Krishna; Narasimhacharyulu, E.; Murthy, D. S. R. (Osmania Univ., Hyderabad, India). pp 84-8 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28-31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

Atomic Theory

Refer also to abstract 50175.

49754 (CONF-690732, pp 1,1-24) CAN THE GROUND STATE OF A MANY-ELECTRON SYSTEM BE DESCRIBED BY THE PARTICLE DENSITY. March, N. H.; Stoddart, J. C. (Sheffield Univ. (England)).

From fourth seminar on theoretical physics; Johannesburg, South Africa (7 Jul 1969).

It is shown that, in a one-particle approximation, the ground state of a many-electron system can be uniquely expressed as a functional of the electron density $\rho(\mathbf{r})$. This is done by showing how the first-order Dirac density matrix may be formally written in terms of the electron density. Thus, the kinetic-energy density and the momentum density can be expressed as functionals of $\rho(\mathbf{r})$. These functionals are displayed explicitly as an expansion in the displaced charge $\rho(\mathbf{r}) - \rho_0$, where ρ_0 is the Fermi gas density in the absence of an external potential. Some attention is then given to the forms of the exchange and correlation energies as functionals of $\rho(\mathbf{r})$. Expansions in the displaced charge, and in terms of a gradient development are exhibited. The theorem of Hohenberg and Kohn, which shows that the ground-state wave function of a many-body system is a unique functional of the electron density, is briefly summarized. (auth)

49755 CUSP CONDITIONS FOR NATURAL FUNCTIONS. Smith, V. H. Jr. (Queen's Univ., Kingston, Ont. Uppsala Univ.). Chem. Phys. Lett.; 9: No. 5, 365-8(1 Jun 1971).

The Kato electron-nucleus (Coulomb) and electron-electron (correlation) cusp conditions are shown to be satisfied by the natural p-particle functions for atomic states. In particular, a necessary and sufficient condition that a wave function satisfy the Coulomb cusp constraint is that its occupied natural spin orbitals do. Similarly a wave function will satisfy the correlation cusp constraint if and only if its occupied natural spin geminals are so constrained. These may be exploited in the construction of variational wave functions. (auth)

49756 PERTURBATION CALCULATIONS OF THE HELIUM GROUND-STATE ENERGY. Riley, M. E.; Dalgarno, A. (Harvard Coll. Observatory, Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.). Chem. Phys. Lett.; 9: No. 5, 382-6(1 Jun 1971).

A comparison is presented for the ground state of the helium atom of high-order Rayleigh-Schrödinger perturbation theories based upon a hydrogenic, a screened hydrogenic, a Hartree, and a modified Hartree local zero-order hamiltonian. The hydrogenic zero-order schemes are superior to the Hartree zero-order scheme but inferior to the modified Hartree scheme, which yields a substantial improvement in the rate of convergence. (auth)

49757 HALL'S VARIATIONAL PRINCIPLE FOR EXCITED STATES. Thulstrup, P. W.; Oehrn, Y.; Linderberg, J. (Univ., Aarhus, Denmark). Chem. Phys. Lett.; 9: No. 5, 485-8(1 Jun 1971).

It is shown how excited-state energies can be given upper bounds through the use of Hall's functional. Applications to atomic central-field problems are worked out. (auth)

49758 WEIGHTED SMALL GAUSSIAN EXPANSIONS OF SLATER-TYPE ATOMIC ORBITALS. Ehrenson, S. (Brookhaven National Lab., Upton, N. Y.). Chem. Phys. Lett.; 9: No. 6, 521-8(15 Jun 1971).

Small gaussian expansions of Slater-type atomic orbitals are generated under a wide range of radial weighting conditions by full least-squares procedures, and the quality of the wave functions obtained is examined for a particular expectation value, electron density at the nucleus. (auth)

49759 VARIATIONAL LOWER BOUND TO THE OVERLAP FOR EXCITED STATES. Cohen, M.; Feldmann, T.; McEachran, R. P. (Hebrew Univ., Jerusalem). Chem. Phys. Lett.; 9: No. 6, 498-503(15 Jun 1971).

A new variational lower bound to the overlap between an approximate excited-state wave function and the corresponding unknown exact eigenfunction is obtained. The new bound generalizes the classic lower bound of Eckart valid for a ground-state trial function. Numerical values for the helium atom show that the bounds are highly effective. (auth)

49760 EVALUATION OF MATRIX ELEMENTS FROM A GRAPHICAL REPRESENTATION OF THE ANGULAR INTEGRAL. Briggs, John S. (Univ. of Chicago. Argonne National Lab., Ill.). Contract COO-1674-37. Rev. Mod. Phys.; 43: No. 2, 189-230 (Apr 1971).

The graphical representation of angular momentum is used as the basis of a procedure for the complete evaluation of the matrix element of a Coulomb or multipole interaction operator between atomic states having any number of open shells. The method is presented in the form of a step-by-step procedure and is designed to permit straightforward extension to the evaluation of the matrix elements of other types of tensor operators and of sums of products of Coulomb matrix elements, such as occur in the perturbation theory of configuration interaction. (auth)

49761 INTERACTION OF A THREE-LEVEL ATOMIC SYSTEM WITH INTENSE ELECTROMAGNETIC RADIATION. Movsesyan, R. E.; Chaltykyan, V. O. (Inst. of Physical Research, Erevan). Dokl. Akad. Nauk Arm. SSR; 52: No. 1, 33-40(1971). (In Russian).

The simple atomic model employed permits transitions from level 1 to either levels 2 or 3, but the transition $2 \nrightarrow 3$ is considered forbidden. The interaction of the model atom with an electromagnetic wave is mathematically examined with the possibility of absorption and irradiation of given frequency bands and frequency difference of resonance being mathematically considered. (K.S.W.)

49762 ELECTRON SPIN-SPIN CONTACT INTERACTION IN ATOMS WITH f^n CONFIGURATIONS. Saxena, K. M. S.; Lo, B. W. N.; Fraga, S. (Univ. of Alberta, Edmonton). Can. J. Phys.; 49: No. 15, 2031-2(1 Aug 1971).

The expressions of the matrix elements of the electron spin-spin contact interaction were tabulated for all the states arising

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from f^n configurations. Numerical calculations were carried out for a large number of lanthanide atoms and ions using accurate numerical Hartree–Fock functions. (auth)

49763 ENERGY FLUCTUATIONS FOR SOME GAUSSIAN WAVE FUNCTIONS OF COMPLEXITY SIMILAR TO THE HYDROGEN ATOM. Tsapline, Bernard (Battelle Memorial Inst., Geneva). Compt. Rend., Ser. B; 272: No. 20, 1164-7(17 May 1971). (In French).

The quality of some gaussian wave functions is discussed in terms of the energy fluctuation, the behavior at the origin, and the asymptotic behavior. (auth) (France)

Cosmic Radiation

Refer also to abstracts 48996, 49002, 49003, 49005, 49643, 50037, and 50056.

49764 (AD-720896) STUDY OF COSMIC RAYS AT CHACALTAYA, 1968–1970. Final Technical Report. Mejia, Gaston R.; Aguirre, Carlos (Universidad Mayor de San Andres, La Paz (Bolivia). Laboratorio de Fisica Cosmica). Oct 1970. 60p. (AFOSR-70-2511-TR). NTIS.

The aims of the experiment were to study high-energy interactions produced by surviving primary protons of the cosmic radiation at the altitude of Chacaltaya (5200 m.a.s.l.). In 1965, a preliminary experiment performed at Chacaltaya showed that the energy spectrum in the range 10^{12} to 10^{14} eV was steeper than the total energy spectrum of cosmic rays. The present experiment aim was to confirm this preliminary result. This report presents details on the different experimental arrangements used and the scientific results obtained, which were presented in the eleventh International Conference on Cosmic Rays, Budapest, Hungary and at the sixth Interamerican Seminar on Cosmic Rays, La Paz, Bolivia. (auth) (USGRDR)

49765 (NP-18959) COSMIC RAY RECORDS, WILKES 1968. ANARE Data Reports Publication No. 112. Bilson, J. R.; Jelleff, R. O. (Department of Supply, Melbourne (Australia). Antarctic Div.). 1970. 40p. Dep. NTIS (U. S. Sales Only).

Neutron monitor data in uncorrected form, and corrected for barometric pressure variations, is tabulated. (Australia)

49766 (NP-18960) STUDIES OF THE SIDEREAL DAILY VARIATION OF COSMIC RAY INTENSITY WITH PARTICULAR REFERENCE TO OBSERVATIONS AT 40 MWE UNDERGROUND. ANARE Scientific Reports Publication No. 114. Jacklyn, R. M. (Department of Supply, Melbourne (Australia). Antarctic Div.). 1970. 199p. Dep. NTIS (U. S. Sales Only).

An investigation of the apparent sidereal daily variation of meson intensity at depths of approximately 40 m.w.e. underground is described. Continuous records over the years 1958–1965, from vertical telescopes at Hobart, provided the main source of information, in conjunction with data from vertical telescopes at Budapest and from special experiments at Hobart with telescopes inclined 70° north, 30° north, and 45° south of zenith. For comparison with the underground data, the available observations of an apparent sidereal daily variation at sea level were examined. Developments since 1965 are summarized and discussed. (Australia)

49767 (NP-18962) COSMIC RAY RECORDS, MAWSON 1968. ANARE Data Reports Publication No. 111. Vrana, A.; Reilly, J. F. (Department of Supply, Melbourne (Australia). Antarctic Div.). 1970. 109p. Dep. NTIS (U. S. Sales Only).

Tables are given of: (1) hourly data from the vertical telescope; (2) data from the wide-angle inclined-telescope for geomagnetic E and W azimuth headings; (3) data from the high-zenith angle telescope for geographic N and S azimuth headings; (4) uncorrected hourly data from the neutron monitor; (5) neutron monitor data corrected for barometric pressure variations; (6) hourly mean station level pressure; and (7) upper air data from all radiosonde flights conducted from the station. (Australia)

49768 CLUSTERS OF DENSE STARS AND THE INJECTION OF COSMIC RAYS. Boccaletti, D.; de Sabbata, V.; Fortini, P.; Gualdi, C. (Univ., Bologna). Nature (London) Phys. Sci.; 232: No. 29, 53-4(19 Jul 1971).

Consideration is given as to whether clusters of neutron stars could provide a mechanism for the injection of cosmic rays, particularly protons with injection energies >200 MeV. The reason for an interest in these energies is that the chief difficulty with the Fermi model of cosmic-ray acceleration is that, in order for the increase in cosmic-ray energy by scattering off inhomogeneities in the magnetic field to exceed the loss due to nuclear interactions, the minimum injection energy for protons must be 200 MeV. The model discussed overcomes this difficulty of the Fermi theory and also gives the number of particles necessary to maintain the density of cosmic rays in the Galaxy. Particles heavier than protons are also accelerated. The supply of material must be 10^{42} particles per second, which can be obtained either by the infall of gas from the surrounding parts of the Galaxy, or by tide effects during stellar collisions. The mean life of the cluster is also considered; factors affecting this are evaporation of stars, continuous emission of gravitational waves, and emission of gravitational waves in the pulsating mode due to the interaction of a pair of stars, with the last effect predominating. The estimated mean life is 6×10^9 years. (UK)

49769 TIME VARIATION STUDY AND INTENSITY MEASUREMENT FOR THE NEARLY HORIZONTAL COSMIC-RAY MUON COMPONENT. Hicks, R. B.; Flint, R. W.; Standil, S. (Univ. of Manitoba, Winnipeg). Can. J. Phys.; 49: No. 15, 2079-81(1 Aug 1971).

A narrow-angle cosmic-ray particle telescope was operated at Winnipeg, Manitoba for a 2-year period commencing Oct. 16, 1967. The telescope was oriented East–West and was sensitive to muons at zenith angles in the range 86 to 90°. The data were analyzed for solar and sidereal time variations; the results are consistent with zero amplitude within the statistical accuracy of the experiment. An absolute intensity was calculated and is compared with previous measurements. (auth) (Canada)

49770 ENERGY LOSS OF COSMIC RAY MUONS IN THE RANGE 5 TO 40 GeV/c. Ayre, C. A.; Hamdan, M. A.; Hume, C. J.; (and others) (Univ. of Durham, Eng.). J. Phys., A (London); 4: No. 4, L75-7(Jul 1971).

The new Durham Spectrograph, MARS, was used to make a direct measurement of the mean rate of energy loss of cosmic-ray muons in iron in the momentum range 5 to 40 GeV/c. Agreement was found with the predictions of Sternheimer, and Sternheimer and Peierls for ionization loss (together with values for the other losses) to within the statistical errors, which ranged from 2% at 6 GeV/c to 6% at 30 GeV/c. (auth) (UK)

Direct Energy Conversion

Refer also to abstract 49783.

49771 (AD-721460) ELECTRICAL CHARACTERISTICS AND TRANSIENT WAVE GROWTH IN MAGNETOGASDYNAMIC CHANNELS. Powers, Walter Lee (Tennessee Univ., Tullahoma. Space Inst.). 18 Mar 1967. Contract AF33(615)-2691. 97p. (AFAPL-TR-67-33). NTIS.

Thesis.

A graphical display of the generalized Ohm's law is presented which is useful in determining the steady-state electrical characteristics of magnetogasdynamic accelerators and generators. It is shown how this map aids in the selection of the most desirable type of device for a given requirement. The electrical parameters of generators are written in terms of the external resistivity and permit the entire range from short to open circuit to be investigated. A first-order perturbation analysis of the gas-dynamic equations is made which permits an investigation of the initial growth of the transient acoustical response to natural disturbances that may disturb uniform flow conditions in generators. The cubic equation for the dispersion relation resulting from a quasi-one-dimensional plane wave traveling in the channel axial direction is solved numerically for all disturbance wavelengths and all external resistivities of interest in all generators. Results show that the upstream and enthalpy waves can grow considerably in typical channels. (auth) (USGRDR)

49772 (N-71-23117) PERFORMANCE CHARACTERISTICS OF A THERMIONIC CONVERTER WITH A (110) TUNGSTEN EMITTER AND A COLLECTOR OF NIOBIUM WITH TRACE AMOUNTS OF TUNGSTEN AND NIOBIUM CARBIDE ON THE SURFACE. Wilson, V. C.; Podkulski, S. P. (General Electric Co., Schenectady, N. Y.). Apr 1971. Contract NAS3-8511. 69p. (NASA-CR-1702; GESP-9005). NTIS.

A parallel-plane, variable-spaced converter with a tungsten emitter having the (110) planes parallel to the surface and a niobium collector was fabricated. The performance of the converter was mapped for various emitter, collector, and cesium reservoir temperatures and is compared to the performance of a converter having a tungsten (110) emitter and a nickel collector. At low temperatures (emitter temperature = 1673K), the performance of the two converters is comparable. At higher temperatures, the performance of the tungsten (110) niobium converter is lower than the tungsten (110) nickel converter. The output increased during the

first five hours of operation, but after that remained constant for about 100 hours of intermittent operation. (auth) (STAR)

49773 (N-71-23781) REVIEW OF THE OUTPUT PERFORMANCE OF SIX PLANAR THERMIONIC CONVERTER WITH VARIOUS ELECTRODE MATERIALS. Wilson, V. C. (General Electric Co., Schenectady, N. Y.). Apr 1971. Contract NAS3-8511. 67p. (NASA-CR-1814; GESP-9012). NTIS.

The converters tested had electrode surfaces as follows: (1) emitter polycrystalline W, collector Nb; (2) emitter (100) oriented W etched to expose the (110) planes, collector Nb; (3) emitter (100) W, collector Ni; (4) emitter (110) W, collector Nb; (5) emitter (112) to (114) W, collector W + WO_2 on Nb; and (6) emitter (110) W, collector 50% Mo-50% Nb. All of these electrode surfaces were carefully prepared and characterized before and after testing. Of the various emitters tested, emitter (2) with (100) W etched to expose (110) planes performed best. The performance of the Ni collector was superior to that of the Nb. The most output power was obtained from converter (3)-(110) W emitter with Ni collector. (auth) (STAR)

49774 (N-71-23932) RESULTS OBTAINED IN NASA LEWIS CLOSED-CYCLE MAGNETOHYDRODYNAMIC POWER GENERATION EXPERIMENTS. Sovie, Ronald J.; Nichols, Lester D. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Apr 1971. 17p. (NASA-TM-X-2277). NTIS.

Experiments were performed over a wide range of operating conditions with two magnetohydrodynamic channels. Both channels contained 28 pairs of thoriated tungsten electrodes. In the first channel (length 195 cm, height 19 cm, and width 6.35 cm) open-circuit voltages up to 70 V (0.75 theoretical) were obtained. However, short-circuit currents were limited to 100 to 200 mA at equilibrium conditions and to 100 to 800 mA when preionizers and starter circuits were used. The experimentally determined apparent Hall parameter varied from 0.1 to 0.5 for these conditions. The data indicated that large voltage drops near the electrode surfaces were limiting the short-circuit currents. The second channel was used in an attempt to increase the open-circuit voltage and overcome these losses. In this channel, the width was reduced to 3.8 cm in the electrode region. The effects of internal wall and boundary-layer current leakage were accentuated in this channel, and the effect of the latter on plasma parameters is outlined. Possible reasons for the onset of oscillations are discussed. (auth) (STAR)

49775 LOW-VOLTAGE ARC IN A THERMIONIC CONVERTER WITH A HIGHLY IONIZED PLASMA. Baksht, F. G.; Korobova, I. L.; Moizhes, B. Ya. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 2, 292-302(Aug 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 2, 387-400(Feb 1971).

Increasing the current density in a thermionic converter forces a low-voltage arc plasma into a partially or completely ionized state. The equations that describe such a plasma are derived. Computer results on the distribution of parameters are given for several operating regimes. (auth)

49776 ENERGY CONVERSION BY MEANS OF PLASMA MHD GENERATORS. Zinko, H. (Inst. fuer Plasmaphysik, Garching, Ger.). Naturwissenschaften; 58: No. 6, 294-302(Jun 1971). (In German).

The physical basis of plasma MHD generators is described, technological problems connected with both types, i.e., combustion and noble gas MHD generators, are discussed. The present state of development is briefly reviewed. (auth)

49777 STUDY OF MOVEMENT OF TWO-TEMPERATURE PLASMAS IN THE CHANNEL DISKS OF MAGNETOHYDRODYNAMIC GENERATORS. Pribylov, V. N. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza; No. 6, 18-25(Nov-Dec 1970). (In Russian).

Stabilization of one-dimensional flow of dual-temperature partially ionized plasma in the channel of a disk Hall generator is investigated. A simplified formulation of a problem analogous to this one was examined earlier (Michiyoshi and Numano, Plasma Phys., 9: No. 5(1967)). Ionization and recombination reactions are considered here. The equation of energy for an electron gas is taken in differential form, permitting an explanation of the question concerning the applicability of the Kerrebrock formula (AIAA J., No. 6, (1964)) for the difference of temperatures of electrons and heavy particles. (tr-auth)

49778 REDUCTION IN THE ELECTRICAL PERFORMANCE OF AN MHD GENERATOR DUE TO THE GAS BOUNDARY LAYERS. Celinski, Z. (Inst. of Nuclear Research, Swierk, Poland). Arch. Elektrotech. (Warsaw); 20: No. 2, 501-14(1971).

Expressions are derived that enable calculation of the electrical terminal values of a Faraday-type MHD generator with two-dimensional gas flow. These expressions are based on the simple generator theory and three correction parameters λ, ϵ and D. The parameters are defined and their numerical values are calculated for various thicknesses of the gas boundary layers, for various wall temperatures, and for various Hall parameters. The cool-electrode boundary layers deteriorate the generator performance significantly. The cool boundary layers near the side insulating walls give small effects only. (auth)

49779 LEAKAGE CURRENTS IN THE FARADAY-TYPE MHD GENERATOR WITH NONUNIFORM GAS. Celinski, Z. (Inst. of Nuclear Research, Swierk, Poland). Arch. Elektrotech. (Warsaw); 20: No. 2, 515-26(1971).

One-dimensional gas flow in the presence of leakage currents is considered. Results of calculations point out that the current-voltage characteristics of the generator may be strongly nonlinear and a gas-acceleration mode of operation may be established in the outlet part of the generator channel. Next, two-dimensional gas flow in the presence of leakage currents is considered. The possibility of numerical analysis of such problems by means of the equivalent-circuit method is shown. Some interesting effects occurring in such a case are discussed and quantitatively estimated in the numerical example. (auth)

49780 EFFECT OF HETEROGENEITY OF A CONDUCTING FLUID ON THE PERFORMANCE OF A MHD GENERATOR. Chandrasekhara, B. C.; Rudraiah, N.; Kuchela, K. N. (Bangalore Univ., India). Jap. J. Appl. Phys.; 10: No. 8, 1266-73 (Aug 1971).

The effect of heterogeneity of a conducting fluid on the performance of a liquid-metal generator is considered. The results of the investigation show that the density stratification increases the electrical efficiency as well as the output power of the generator for a given aspect ratio. The results are compared with the performance of a generator using homogeneous fluid. (auth)

49781 INFLUENCE OF MAGNETIC FIELD ON THE VOLTAGE-CURRENT CHARACTERISTICS OF A Cs-Ba THERMIONIC CONVERTER. Kucherov, R. Ya.; Nevolin, V. K.; Yarygin, V. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 3, 450-2(Sep 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 3, 581-3(Mar 1971).

It is shown that the output of a Cs-Ba thermionic converter can be limited substantially by the pressure differential due to ponderomotive forces. (auth)

Fluid Physics

Refer also to abstract 51205.

49782 (UCRL-73038) COMPUTATIONAL PROBLEMS IN MAGNETOHYDRODYNAMICS. Killeen, John (California Univ., Livermore. Lawrence Radiation Lab.). 8 Feb 1971. 44p. (CONF-710805-2). Dep. NTIS.

From IFIPS congress; Ljubljana, Yugoslavia (Aug 1971).

A number of numerical methods that have proved useful in solving the equations of magnetohydrodynamics are reviewed. The problems that are considered have arisen in the physics of ionized gases as applied to the controlled thermonuclear research program. Similar problems occur in astrophysics, space science, and geophysics. Initial-value problems in one and two dimensions are considered first. A survey is given of both explicit and implicit finite difference schemes that are used to solve these problems. The models include both hyperbolic and parabolic systems of differential equations. Time-independent problems are also considered which involve the numerical solution of plasma equilibria in complicated magnetic field configurations. These nonlinear elliptic equations in two and three dimensions are solved by iterative methods which are described. (auth)

49783 CERTAIN PECULIARITIES OF THE SUPERSONIC FLOW OF ELECTROCONDUCTIVE GAS IN MGD CHANNEL. Gubarev, A. V.; Degtyarev, L. M.; Favorskii, A. P. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza; No. 3, 10-22(May-Jun 1969). (In Russian).

Supersonic flow of conducting gas in crossed electric and magnetic fields in the presence of shock waves was studied by Sutton and Sherman (1968). The possibility of existence of three regimes of steady flow, determined by the dependence of electric conductivity of the gas on temperature and density was shown: (1) normal regime characterized by the tendency of progressive discontinuities at channel entrance with increase of static pressure at exit from

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channel; (2) anomalous regime (formally constructed) characterized by the tendency of transfer of discontinuities to the exit with increase of pressure at the exit; this regime is unstable and flow in channel can be either completely supersonic or subsonic; and (3) saturated (boundary) regime intermediate between the other two, characterized by the fact that the steady position of the shock wave and its amplitude are not determined unequivocally; steady flow in this case is not unique. These regimes are investigated here by formal construction of equations for both the steady-state and corresponding nonsteady-state problems. The fitting of the steady-state regime with the nonsteady-state solution simultaneously is the check of its stability. (tr-auth)

49784 STABILITY OF COUETTE–POISEUILLE PLANE FLOW IN THE PRESENCE OF MAGNETIC FIELD. Sagalakov, A. M. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza; No. 6, 11-17(Nov-Dec 1970). (In Russian).

The hydrodynamic stability of plane Couette–Poiseuille flow of viscous conducting fluid in a transverse magnetic field is studied in the framework of linear theory. For characteristic Hartmann numbers, the complete spectrum of small perturbations is studied; the perturbations are classified according to the behavior of their phase velocity at higher wave numbers. The ratio of critical Reynolds number and critical wave number was obtained from the parameter that characterizes the relation between parts of the flow given by the movement of plates and the pressure gradient. The character of asymptotic relations at greater Hartmann numbers is clarified. An example of a neutral curve formed by two branches of neutral oscillations is given. (tr-auth)

49785 MAGNETOHYDRODYNAMICS OF PLANE FLOWS IN PLASMA WITH ANISOTROPIC PRESSURE. Baranov, V. B.; Kartalev, M. D. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza; No. 6, 3-10(Nov-Dec 1970). (In Russian).

On the basis Chew–Goldberger–Low equations, certain types of plane flows of plasma with anisotropic pressure (pressure along magnetic field not equal to pressure across magnetic field) were investigated. Surface relations of strong discontinuities obtained earlier (Lynn, Phys. Fluids, 10: No. 10(1967)) are used for the investigation of the change of parameters in weak shock waves in the linear approximation. Also, in the linear approximation, problems slightly varied from the homogeneous flow of plasma at infinity are considered. Analogous MHD problems (with isotropic pressure), considered previously by others, are also treated here. (L.M.T.)

Geophysics (Upper Atmosphere)

Refer also to abstract 49696.

49786 (AD–715271) LOW-ENERGY GAMMA RAYS IN THE ATMOSPHERE. Pushkin, Jerome S. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). 30 Jun 1970. 114p. (SAO-SR–318). NTIS.

The low-energy (0.3 to 10 MeV) gamma-ray flux at balloon altitude (3.5 mb) and at medium latitude (~42°), resulting from energetic particle interactions with atmospheric atoms, was calculated from measured particle intensity vs depth profiles. Electron bremsstrahlung was found to be the dominant source of such photons, with a substantial contribution from positron annihilation gamma rays in the 0.3 to 0.51-MeV region. The intensity of low-energy atmospheric photons was found to be strongest in the upwards and sidewards directions. The energy and angular response of a typical low-energy detector (3 inch × 3 inch NaI crystal) was investigated. Finally, the response of such a detector to the atmospheric flux calculated earlier was predicted and found to be in good agreement with experiment. (auth) (USGRDR)

49787 (AD–718861) DOUBLE PROBE MEASUREMENTS OF DC ELECTRIC FIELDS WITH THE INJUN 5 SATELLITE. Progress Report. Cauffman, David P.; Gurnett, Donald A. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Jan 1971. Contracts N00014-68-A-0196-0003; NAS5-10625. 77p. NTIS.

The operation and results of the double-probe dc electric-field experiment on the low-altitude polar-orbiting Injun-5 satellite are reported. At middle and low latitudes, where the convection electric field is generally very small, the operation of the double-probe electric-field antenna is investigated by comparing measured electric fields with the $\vec{V}_s \times \vec{B}$ electric field generated by the satellite motion through the ionosphere. Errors caused by sunlight shadows on the probes, wake effects, and antenna impedance variations are discussed. (auth) (USGRDR)

49788 (AD–721081) DISTRIBUTIONS OF PLASMAS AND ELECTRIC FIELDS OVER THE AURORAL ZONES AND POLAR CAPS. Frank, L. A.; Gurnett, D. S. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Feb 1971. Contracts N00014-68-A-0196-003; NAS5-10625. 56p. NTIS.

Simultaneous observations of dc electric fields and low-energy charged particles at low altitudes over the Earth's auroral zones and polar caps were obtained with the satellite Injun 5. Several of the principal results for the evening and dawn local time sectors are summarized. (USGRDR)

49789 (AD–721183) POLAR RIOMETER OBSERVATIONS. Cormier, Raymond J. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). 3 Dec 1970. 22p. (AFCRL–70-690; AFCRL-ERP–344). NTIS.

Qualitative descriptions of the morphology of polar-cap absorption (PCA) events are given, using data from the following riometer stations: Thule and Godhavn, Greenland; Churchill Range, Manitoba, Canada; and Reykjavik (Leirvogur), Iceland. The dependence of commencement time on solar zenith angle and subsequent daily variations in absorption following the initial day are described. The morphology of PCA events is very important for forecasting the behavior of ionospheric absorption during a PCA event. It is shown that, besides information concerning the energy spectrum of the proton flux, the season and time of day must also be considered for forecasting the expected absorption. (auth) (USGRDR)

49790 (AD–721200) TYPES Pc 1–2 AND IPDP MICROPULSATIONS IN THE AURORAL ZONE. Final Report, November 1, 1967–October 31, 1970. Heacock, Richard R. (Alaska Univ., College. Geophysical Inst.). Jan 1971. Contract F19628-68-C-0121. 128p. (UAG-R–215; AFCRL–71-97). NTIS.

A micropulsation recording program was carried out at College and Anchorage, Alaska and at Bar I, Canada, with induction magnetometers. The analysis program centered mainly on synoptic and polarization characteristics for types Pc 1–2, IPDP, and Pi-burst micropulsation events. Summaries of the known morphological features for structured Pc-1 and structured Pc 1–2 micropulsations are given. The synoptic studies disclosed latitude relationships between unstructured Pc 1–2, IPDP, and Pi-burst events. At the onset of a polar substorm, Pi bursts occur near midnight at 65 to 70° geomagnetic latitudes. IPDP events follow the Pi burst and are seen in evening hours at 60 to 65° latitudes. IPDP events seen in afternoon hours are often preceded by unstructured Pc 1–2 activity, which maximizes a few degrees polewards of the IPDP. The IPDP events are seen in the evening-bulge region of the plasmasphere. The proton plasma requirement for IPDP wave generation suggests that protons injected near midnight in the Pi-burst event drift westwards into the bulge and generate unstructured Pc 1–2 and IPDPs there. (auth) (USGRDR)

49791 (AD–721589) IONOSPHERIC EFFECTS (POSSIBLY FROM INTERNAL GRAVITY WAVES) ON TOTAL ELECTRON CONTENT DURING THE SOLAR ECLIPSE OF MARCH 7, 1970. Research and Development Technical Report. Arendt, P. R. (Army Electronics Command, Fort Monmouth, N. J.). Dec 1970. 25p. (ECOM–3376). NTIS.

Variations of the total ionospheric electron content are assumed to indicate the motion of eclipse-produced internal atmospheric gravity waves. Variation of the electron content before, during, and after the eclipse of March 7, 1970 was obtained from polarization of ATS-3 and S-66 BEC satellite signals. The average period of the content variations was found to be 18 ± 3 minutes. From BEC observations across the predicted wake of the gravity waves, an estimate was made of the wavelength and velocity of the atmospheric undulations and found to be 320 km and 296 m/sec, respectively. (auth) (USGRDR)

49792 (AD–722435) HIGH-LATITUDE SPORADIC E. Pittenger, Eugene W.; Gassmann, George J. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). 5 Feb 1971. 66p. (AFCRL–71-82; AFCRL-ERP–347). NTIS.

Previous research results on high-latitude sporadic E are surveyed and replotted and displayed in corrected geomagnetic latitude (CGL) AND corrected geomagnetic time (CGT) and related to current research results. Patterns of occurrence of sporadic E are developed, showing percent of time of occurrence in location in the CGL/CGT coordinate system, in terms of sporadic-E top frequency (fE_s) and magnetic-activity level. Patterns of E_s occurrence are related to concepts of the auroral oval, polar cap, and substorms. Sporadic E with top frequency ≥MHz is related to substorms. This sporadic E occurs in the late evening–early night sector of the CGL/CGT coordinate system. Implications of sporadic E on high-latitude hf propagation during solar-cycle maximum and minimum are discussed. (auth) (USGRDR)

49793 (N-70-19889) MATHEMATICAL ANALYSIS OF APERIODIC EVENTS (GEOMAGNETIC ACTIVITY). Final Technical Report. Crooker, Nancy U.; Moe, Kenneth (McDonnell Douglas Astronautics Co., Santa Monica, Calif. Space Sciences Dept.). Aug 1969. Contract NAS8-30156. 46p. (NASA-CR-102470; MDC-G-1142). NTIS.

A new method of making short-term predictions of K_p and A_p was developed and tested using the available solar and geophysical data for 1968. The method employs Pioneer-7 measurements of the solar-wind speed as basic data. An attempt is made to separate the contributions to K_p from recurrent storms and from flare-associated storms by using various storm precursor data. The first test of the method failed to produce the hoped-for improvement, but did not disprove the method because the flare-associated precursors did not cover the full 24-hour day, and only one ten-minute sample of the solar-wind speed was available each day. A further-test of the method would be desirable when complete data becomes available. Long-term predictions of the annual average of K_p and the Zurich relative sunspot number were also developed. These predictions are based on earlier work by Gnevyshev, King-Hele, and Xanthakis. Predicted values for each year until 2030 are presented in graphical and tabular form. (auth) (STAR)

49794 (N-70-37391) EQUILIBRIUM OF THE MAGNETOPAUSE CURRENT LAYER. Su, Shin-Yi; Sonnerup, Bengt U. O. (Dartmouth Coll., Hanover, N. H. Radiophysics Lab.). Jun 1970. 24p. NTIS.

Confinement of a uniform magnetic field by a warm hydrogen plasma with an average velocity parallel to the confined field is studied. It is found that, for a given proton temperature, equilibria exist whenever the electron temperature exceeds a certain critical value. Thus, at the magnetopause, equilibrium states may exist near the nose of the magnetosphere but usually not along the tail. A comparison is made with the results of Parker and Lerche. The properties of the equilibrium solutions are discussed. Finally, the equilibrium confinement with the incident streaming plasma tangential to the magnetopause but perpendicular to the confined field is treated. It is concluded that, in the geomagnetic equatorial plane, magnetopause equilibria may occur on the afternoon side but not on the morning side of the magnetosphere. (auth) (STAR)

49795 (N-71-12768) PLASMA PROBE C, D, AND E. VOLUME 1. Final Engineering Report. Rivas, R. A.; Aalami, Dean; Evelyn-Veere, Rene (Time-Zero Corp., Torrance, Calif.). [1970]. Contract NAS2-3374. 324p. (NASA-CR-73486). NTIS.

The Plasma Probe instrument was designed for the Pioneer C, D and E spacecraft to measure ion and electron density and angular distribution in outer space. An electrometer amplifier converts the negative and positive ion flux collected on its target to a bipolar signal proportional to the energy per unit charge as determined by the optic electrostatic potential, solar-wind flux, and direction. The output is dc-compressed at $\frac{2}{3}$ of full-scale input to keep the output swing to a reasonable value in measuring five magnitudes of signal range. The output is positive for negative particles and negative for positive ions. A compression and pulse-width modulator performs a linear logarithmic compression on the piece-wise linear output of the electrometer amplifier. The output of this section is a pulse with modulated signal logarithmically proportional to the input flux. Maximum pulse width is equal to minimum flux and minimum pulse width is equal to maximum flux. (auth) (STAR)

49796 (N-71-12769) PLASMA PROBE C, D, AND E. VOLUME 2. Final Engineering Report. (Time-Zero Corp., Torrance, Calif.). [1970]. Contract NAS2-3374. 358p. (NASA-CR-73487). NTIS.

Integrated circuits were designed for high-speed, general-purpose digital applications where high dc-noise margin and relatively low-power dissipation are important system considerations. Definitive specifications are provided for operating characteristics over the full military temperature range of −55 to +125°C. This logic series includes the basic gates, flip-flop elements, and complex logic and storage elements needed to perform all functions of general-purpose digital systems. Comprehensive laboratory tests were conducted to determine noise immunity data of these units at temperatures of 0 to 130°F. The results are tabulated in this section along with the manufacturers specifications. (auth) (STAR)

49797 (N-71-22496) CHANGES IN THE DISTRIBUTION OF LOW-ENERGY TRAPPED PROTONS ASSOCIATED WITH THE APRIL 17, 1965, MAGNETIC STORM. Burns, A. L.; Krimigis, S. M. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Mar 1971. Contract N00014-68-A-0196-0003. 55p. (NASA-CR-117839). NTIS.

The absolute intensity of geomagnetically trapped protons in the energy ranges $0.52 \leq E_p \leq 4.0$ MeV and $0.90 \leq E_p \leq 1.8$ MeV was measured with the solid-state proton detector on the University of Iowa low-altitude (initial apogee 2502 km, perigee 527 km), high-latitude (inclination 81°) satellite injun 4 for the period March 1 to May 31, 1965. A study of the temporal variations of these fluxes associated with the April 17, 1965 magnetic storm (sc 1313 UT April 17, main phase onset approximately 0200 UT April 18) shows a general redistribution of these protons for $L > 2.5$ and all sampled local geomagnetic-field vector ranges, which persisted for at least 36 days after the storm. The effect of the sudden commencement was a general depression in the intensities and a hardening of the energy spectrums, although the intensities recovered to their prestorm level during the initial phase. The major redistribution was apparently initiated by the polar substorm which began at approximately 0620 UT on April 18 and continued long after (to 1100 UT) the substorm had subsided (approximately 0800 UT). (auth) (STAR)

49798 (NP-18976) SOUNDING ROCKET EXPERIMENT FOR MEASURING ENERGETIC CHARGED PARTICLES. Scientific/Technical Report No. 33. Lindalen, H. R.; Soeraas, F.; Aarsnes, K. (Bergen Univ. (Norway). Dept. of Physics). Mar 1971. 20p. Dep. NTIS (U. S. Sales Only).

Since 1962 a number of rockets have been launched from the Norwegian rocket range at Andøya. (69.4 N, 16.1 E.) These rockets have been instrumented by different scientific groups interested in the physics of the upper atmosphere and the magnetosphere, and have carried aloft payloads capable of measuring simultaneously a number of parameters pertinent to the understanding of the physical processes involved. As a part of an integrated payload, the Department of Physics, University of Bergen, has flown a solid-state charged-particle spectrometer in order to measure the fluxes and energy spectra of electrons in the energy range 30 to 300 keV, and of protons in the energy range 100 keV to 5 MeV. It is the purpose of this note to report on techniques employed in the charged-particle experiment and to describe the electronic circuitry involved. (Norway)

49799 (NP-18977) VARIATIONS IN THE HIGH LATITUDE PROTON TRAPPING BOUNDARY ASSOCIATED WITH POLAR MAGNETIC SUBSTORMS. Scientific/Technical Report No. 31. Lindalen, H. R.; Soeraas, F.; Aarsnes, K.; Amundsen, R. (Bergen Univ. (Norway). Dept. of Physics). Jan 1971. 29p. Dep. NTIS (U. S. Sales Only).

Protons in the energy range (100 to 200) keV in the noon–midnight meridian plane were studied from data obtained by the ESRO IA satellite. From this study it is observed that, during quiet geomagnetic conditions, there is a single zone of precipitating protons located at an invariant latitude of 67° on the nightside and two zones located at invariant latitudes of 70 and 77° on the dayside. Closely correlated with the polar magnetic substorm, the proton-trapping boundary moves poleward, the two zones of proton precipitation on the dayside merge into one zone, and the energy input into the atmosphere increases. Preceding the poleward movement of the trapping boundary, there is an intensity increase in the already-existing proton precipitation on the nightside. (Norway)

49800 (NRC-TT-1458) STATISTICAL PROPERTIES OF THE HELIUM EMISSION. Shefov, N. N. Translated by H. R. Hayes (National Research Council of Canada, Ottawa), from Polyar. Siyaniya Svechenie Nochnogo Neba, Ser. Rezul't. MGG, Sb. Statei; No. 13, 64-8(1966). 8p. Dep. NTIS (U. S. Sales Only).

Statistical treatment of observational data of helium emission indicates considerable variations in the uv radiation of the Sun during the solar cycle and over a period of 27 days. A relationship has been established between electron fluxes of about 25 eV and magnetic activity. (auth)

49801 MAGNETICALLY CONJUGATE OBSERVATIONS OF THE RADIO AURORA. Ecklund, W. L. (National Oceanic and Atmospheric Administration, Boulder, Colo.); Unwin, R. S. Nature (London) Phys. Sci.; 232: No. 29, 54-6(19 Jul 1971).

It is believed that close correspondence can exist between magnetic variations, precipitating particle fluxes, and optical emissions at conjugate auroral latitudinal locations; what are believed to be the first-reported conjugate observations of the E-region radio aurora are presented. The radio aurora consists of field-aligned electron-density irregularities thought to arise through plasma instabilities generated by electric fields, in which case the observations have a bearing on conjugate E-region electric fields at auroral latitudes. The equipment used is briefly described; it consisted of pulsed vhf auroral radars at Slope Point, New Zealand (69 MHz) and Anchorage, Alaska (50 MHz). The nature of the observed echoes is described and discussed in detail. (UK)

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49802 STUDY OF THE OSCILLATIONS STIMULATED AT THE UPPER HYBRID RESONANCE BY A PULSED DIPOLE ANTENNA IN A WEAKLY INHOMOGENEOUS PLASMA. Graff, Philippe (Centre National de la Recherche Scientifique, Issy-les-Moulineaux, France). J. Plasma Phys.; 5: 427-39(Jun 1971).

The oscillations, excited by a pulsed dipole antenna at the upper hybrid resonance in a weakly inhomogeneous plasma, are investigated by the Wentzel–Kramers–Brillouin (WKB) approximation. In addition to a direct component, the field at a given distance from the transmitter is shown to consist in two obliquely reflected rays when the upper hybrid frequency ω_T is less than twice the electron gyro-frequency ω_H. The analytical expressions of the frequencies of the echoes intercepted by a moving receiver are given and the influence of the reception time t, the velocity V_S of the receiver and the parameters of the plasma are thus pointed out. As distinct from previous studies, the static magnetic field B_0, the velocity of the receiver, and the gradient of the electron density $\partial N/\partial X$, are here vectors of arbitrary directions. The choice of such a general model makes it possible to interpret most of the experimental data concerning the upper hybrid resonance in the ionosphere. (auth) (UK)

49803 MASS SPECTROMETRIC MEASUREMENTS OF NEGATIVE IONS IN THE D AND LOWER E REGIONS. Narcisi, R. S.; Bailey, A. D.; Della Lucca, L.; Sherman, C.; Thomas, D. M. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Atmos. Terrest. Phys.; 33: No. 8, 1147-59(Aug 1971).

Cryopumped quadrupole mass spectrometer systems were utilized to measure the negative-ion composition in the lower ionosphere between 73 and 117 km. Two night-time rocket flights launched on August 13, 1969 at 0423 UT and October 11, 1969 at 0200 UT from the Fort Churchill, Canada range are reported. The first spectrometer had a scanning range of 12 to 79 amu and the second a scanning range of 12 to 162 amu. Heavy ions with masses near 60, 62, 76, 78(?), 80, 98, 116, 134, and 152 amu were measured in relatively large concentrations between 73 and 90 km. These heavy ions were the dominant species in the D region and were restricted to altitudes below about 90 km. Possible identities for the heavy ions are presented. Between 90 and 92 km the total negative-ion concentration decreased by almost two orders of magnitude. Lighter ions with masses 16, 35/37, and 46 amu, probably O^-, Cl^- (perhaps a contaminant), and NO_2^- were predominant above 90 km but present in relatively small concentrations. (auth) (UK)

49804 REMOVAL OF nπ AMBIGUITY IN OBSERVATIONS OF TOTAL ELECTRON CONTENT. Smith, D. H. (School of Electrical Engineering, Sydney). J. Atmos. Terrest. Phys.; 33: No. 8, 1161-8(Aug 1971).

Two of the main sources of error in converting observations of the Faraday-rotation angle of a signal from a geostationary satellite into total electron content (N_T) are the uncertainty in the baseline, corresponding to the initial polarisation, and the uncertainty in the total number of rotations—the "nπ ambiguity". A new method of resolving the nπ ambiguity through the use of critical-frequency data is described. The method was applied to data obtained at Sydney from Syncom 3. Results suggest that this comparatively simple method is quite reliable. The same method was used to estimate the zero for absolute measurements of N_T. It appears to give consistent results but yields a value that is rather different from that calculated on the basis of data previously published on Syncom 3. (auth) (UK)

49805 NEGATIVE IONS IN THE LOWER IONOSPHERE: A MASS-SPECTROMETRIC MEASUREMENT. Arnold, F.; Kissel, J.; Krankowsky, D.; Wieder, H.; Zaehringer, J. (Max-Planck-Institut fuer Kernphysik, Heidelberg). J. Atmos. Terrest. Phys.; 33: No. 8, 1169-75(Aug 1971).

The results of a measurement of negative ions in the nighttime D region above 71 km are presented. Below 78 km ions with masses 60, 35, 61, and 62 are predominant. They are tentatively identified as CO_3^-, Cl^-, HCO_3^- and NO_3^- above 78 km their concentrations decrease rapidly. Heavy cluster ions with masses 111 ± 1 and 125 ± 1 dominate. In addition several other ions having smaller concentrations were detected. (auth) (UK)

49806 COMPARISON OF SCINTILLATION, SPREAD-F, AND ELECTROSTATIC-PROBE OBSERVATIONS OF ELECTRON-DENSITY IRREGULARITIES. Dyson, P. L. (La Trobe Univ., Bundoora, Australia). J. Atmos. Terrest. Phys.; 33: No. 8, 1185-92(Aug 1971).

A comparison is made of Alouette-II topside sounding and electrostatic-probe measurements of electron-density irregularities with near-simultaneous BE-B scintillation observations and ground-based ionosonde data. The topside sounding technique was found to be the most sensitive means of detecting irregularities followed by scintillation, bottomside sounding and electrostatic probe. Hence, combining the results of different experiments can present difficulties in interpretation. The results indicate the need for further direct measurements of irregularity characteristics particularly near the F2-layer peak. (auth) (UK)

49807 IONOSPHERIC E-REGION NIGHTTIME MODEL. Chen, W. M.; Harris, R. D. (Utah State Univ., Logan). J. Atmos. Terrest. Phys.; 33: No. 8, 1193-1207(Aug 1971).

Five rocket flights were launched from Wallops Island during a 6-hr period on the morning of February 22, 1968. Electron-density profiles were measured with a Langmuir probe during ascent and glowing vapor was released for wind measurements during descent. The measured winds were combined with a theoretical E-region model to evaluate scattered solar Lyman-β radiation as a nighttime ion production source using individual ionization profiles. The E-region ionization model included standard ion chemical reactions and laboratory values for rate coefficients. Results showed that the major features of the observed nighttime electron-density profiles could be duplicated with molecular ions if wind transport effects and a nighttime ion production source were included. The persistence of two-ion layers below 105 km, however, suggested the origin of metallic ions on this particular night. The ionization level for the nighttime profiles was adequately supplied by the assumed Lyman-β brightness (10 rayleighs). The theoretical dawn profile (0602 EST and 98° zenith angle) required an increase of 3 in the Lyman-β brightness to achieve agreement with the experimental profile. This increase in the scattered radiation was shown to be consistent with measurements and radiation transport calculations. (auth) (UK)

49808 STUDIES OF NIGHTTIME E_s AT IBADAN NEAR THE MAGNETIC EQUATOR. Awe, O. (Univ. of Ibadan, Nigeria). J. Atmos. Terrest. Phys.; 33: No. 8, 1209-22(Aug 1971).

The behaviour of sporadic E-layers that occur during the night hours from 1900 to 0500 LMT was studied at Ibadan (dip = 6°S) over a 13-yr period from 1954 to 1966. The occurrence frequency shows no clear dependence on solar activity, and over the entire period, E_s occurs on an average of 40% of the nighttime hours. There is no marked seasonal variation of occurrence frequency but there is a tendency towards occurrence minima at the equinoxes. The frequencies f_0E_s and f_bE_s show negative correlation with solar activity but are unaffected by magnetic disturbance. The preferred virtual height of the E_s layer ($h'E_s$) is 100 km, and the medium values of $h'E_s$ vary over a range of 10 km during the period of high sunspot numbers. None of the characteristics of nighttime E_s studied shows any lunar tidal effects. (auth) (UK)

49809 IONOSPHERIC F-REGION STORM. King, G. A. M. (DSIR, Christchurch, New Zealand). J. Atmos. Terrest. Phys.; 33: No. 8, 1223-40(Aug 1971).

By computer modelling it is shown that the daytime ionospheric storm has two distinct causes. The positive storm, when f_0F2 is raised, is due to the upward drift of ionization. The negative storm is due to an increased recombination rate. In the discussion it is argued that the latter is brought about by the mixing action of atmospheric waves. Although both processes will operate at night it is pointed out that other processes that are ineffective by day may then become important. (auth) (UK)

49810 ATMOSPHERIC EXCITATION AND IONIZATION BY IONS IN STRONG AURORAL AND MAN-MADE ELECTRIC FIELDS. Cole, K. D. (La Trobe Univ., Bundoora, Australia). J. Atmos. Terrest. Phys.; 33: No. 8, 1241-9(Aug 1971).

Ions gyrating in crossed electric (E) and magnetic (B) fields may acquire an energy of $2mE^2/B^2$. In electric fields found near auroras, ions acquire sufficient energy to excite and sometimes also to ionize molecules. On the assumption that the subsequent emission contributes significantly to the flow outside of discrete auroral forms, cross sections for excitation of atmospheric species by low energy ions (1 to 30 eV) are found. When these cross sections become known, the electric field may be estimated from ground-based measurements of this glow. At the greater field strengths (≳250 mV/m) ionization of the air and also excitation of helium to the $2\,^3S$ state may occur. The ionization may be sufficient to sustain the ionosphere near the aurora. An experiment to test the theory is proposed in which Ba^+ (a heavy ion) is injected into the auroral ionosphere. The need for cross sections for excitation and ionization by ions is evident to understand the physics of strong electric fields in the ionosphere, and vice versa; field and photometric measurements in the auroral atmosphere may provide useful guide lines in designing laboratory experiments. The application of strong (by natural standards) electric fields to the upper atmosphere from rockets or orbiting vehicles and study of the resultant glows should be of value in understanding

not only aspects of the aurora but also of the electrodynamics of the thermosphere. (auth) (UK)

49811 SOLAR-CYCLE CONSTANT FOR EQUATORIAL IONOSPHERIC ABSORPTION. Mbipom, E. W. (Ahmadu Bello Univ., Zaria, Nigeria). J. Atmos. Terrest. Phys.: 33: No. 8, 1263-5 (Aug 1971).

From additional data for absorption of radio waves at vertical incidence, the dependence of absorption on solar activity at Ibadan and Colombo is re-examined. It is found that the solar-cycle constant is 4.9×10^{-3} at Ibadan and 5.1×10^{-3} at Colombo showing that there is no discrepancy in the dependence of absorption on solar activity at these two equatorial stations as hitherto reported. (auth) (UK)

49812 THEORY OF ATMOSPHERIC TIDES. Covez, L. (Faculty of Science, Paris). J. Atmos. Terrest. Phys.: 33: No. 8, 1273-5(Aug 1971).

The solar semidiurnal atmospheric tide is explained by a near resonance between two natural frequencies that appears when the stratification of the atmosphere is taken into account, using the theory of stochastic equations. (auth) (UK)

49813 ELECTRON TEMPERATURE DEPENDENCE OF F-REGION ABSORPTION. Kumari, Sudesh; Mahajan, K. K. (National Physical Lab., New Delhi). J. Atmos. Terrest. Phys.: 33: No. 8, 1277-9(Aug 1971).

From energy balance considerations in the ionosphere, it is shown that F-region absorption, A_F, should be a function of the difference between electron and ion temperatures alone. This is tested by using the calculated values of A_F from radar backscatter measurements of electron temperature and electron concentration and is found to be true. (auth) (UK)

49814 CLUSTER IONS AND NITRIC OXIDE IN THE D REGION. Hunt, B. G. (Commonwealth Meteorology Research Centre, Melbourne). J. Atmos. Terrest. Phys.; 33: No. 6, 929-42(Jun 1971).

A somewhat speculative reaction scheme is advanced to account for the existence of H_3O^+ and $H_5O_2^+$ ions in the mesosphere. The precursor for these ions is shown to be NO^+ rather than O_2^+ on the basis of the reaction $H + (NO^+ \cdot H_2O) \rightarrow H_3O^+ + NO$ proposed by Burke (1970). The rapid decline in the observed H_3O^+ and $H_5O_2^+$ ion concentrations above 80 km is attributed to the reaction of atomic oxygen with constituents in the reaction chain. The use of observed NO distributions in the mesosphere is shown to result in excessively high electron concentrations, unless it is assumed that NO^+ cluster ions with very high dissociative recombination rates are formed. Fairly good agreement between the calculated ion and electron densities and observation is obtained, but a substantial amount of laboratory work is required to verify the proposed reaction scheme. (auth) (UK)

49815 CONDITIONS FOR MAGNETIC INTERACTION OF ASTEROIDS WITH THE SOLAR WIND. Greenstadt, E. W. (TRW Systems Group, Redondo Beach, Calif.). Icarus; 14: No. 3, 374-81(Jun 1971).

Conditions are presented for maintenance of asteroid magnetospheres by dipole moments and for propagation of whistler-mode noise in the solar wind at asteroid distances. Surface field intensities less than one thousandth that of the Earth are found adequate for supporting magnetospheres in the quiet solar wind surrounding the larger asteroids. Magnetospheric diameters are likely to be small, however, and difficult to identify without targeted, close-approach flybys. Under most ordinary conditions, whistler noise generated in an asteroidal shock or by other interaction with the solar wind will not propagate back upstream toward the Sun, but may form a detectable wake downstream. Pure standing whistler wave fronts could be a unique asteroidal phenomenon. (auth)

49816 PARAMETRIC EXCITATION IN THE IONOSPHERE. Wong, A. Y.; Taylor, R. J. (TRW Systems, Redondo Beach, Calif.). Phys. Rev. Lett.; 27: No. 10, 644-7(6 Sep 1971).

The parametric excitation of ion waves in the ionosphere by irradiation with an electromagnetic wave at the characteristic electron frequency for the desired height is reported. When an electromagnetic wave is incident upon the ionosphere it can stimulate the emission of an ion mode. In the ionosphere where the gradient is gentle, the ion wave facilitates the coupling between the long-wavelength electromagnetic wave and the electrostatic electron wave of much shorter wavelength. The excited wave can either be a purely growing mode (the nonoscillatory parametric instability) or a propagating ion-acoustic mode. The experimental investigation of the excited ion waves utilizes the fact that the spectrum of the excited electron-plasma oscillations reflects the presence of parametrically excited ion waves. The measurements of the line shape, the power dependence, and a consideration of the matching between incident electromagnetic waves have shown that ion waves can be excited parametrically in the ionosphere by means of hf electromagnetic waves matched to a characteristic electron frequency. (J.C.W.)

49817 PLASMASPHERE AND ITS ROLE IN THE GENERATION OF MAGNETIC VARIATIONS. Vero, Jozsef (Geodetic and Geophysical Research Inst., Sopron, Hungary). Fiz. Szemle; 21: No. 4, 100-3(Apr 1971). (In Hungarian).

The plasmasphere is filled with collisionless plasma, consisting mostly of ionized hydrogen, i.e., protons and thermal electrons. Its existence has been proven by satellite measurements. The upper boundary in the magnetosphere lies at about 4 to 5 Earth radii and is designated as the plasmapause. The plasmasphere and the plasmapause play an important role in several phenomena, such as the propagation of vlf radio waves, the nighttime warming of the F layer and the creation of electric fields. Correlations have been established between the plasmapause and geomagnetic micropulsations, offering a tool to examine the conditions prevailing at the plasmapause. As the plasmapause represents a new maximum of the hydromagnetic waves in the magnetosphere, the creation of a resonant space must be taken into account between the velocity maximum above the ionosphere and the plasmapause. Pulsation data collected for many years offer an opportunity to study the state of the plasmasphere. (TTT)

Low-Temperature Physics and Cryogenic Equipment

Superfluidity

49818 EXOTIC NEGATIVE CARRIERS IN LIQUID HELIUM. Ihas, G. G.; Sanders, T. M. Jr. (Univ. of Michigan, Ann Arbor). Phys. Rev. Lett.; 27: No. 7, 383-6(16 Aug 1971).

The existence of a new negative carrier of high mobility in superfluid helium, reported by Doake and Gribbon (Phys. Lett., 30A: 251(1969)) was confirmed, and its zero-field mobility was determined. It is suggested that it may be the negative helium ion in a small cavity in the liquid. A series of carriers with mobilities between that of the "fast" and the "normal" (electron bubble) carrier is also shown to exist. (auth)

49819 IDEAL SECOND SOUND RESONANCE IN He II. Vidal, F.; Simon, Y. (CNRS, Paris). Phys. Lett.; 36A: No. 3, 165-6(30 Aug 1971).

The second sound resonance is studied with a very sensitive technique. Excellent agreement with the linear theory is found. Absence of time delays (to 5×10^{-6}s) in the ac heat flow across a metal–He-II interface is shown. (auth)

49820 HIGH-FREQUENCY ULTRASONIC ATTENUATION IN SUPERFLUID HELIUM UNDER PRESSURE. Jaeckle, J. (Univ., Geneva); Kehr, K. W. Phys. Rev. Lett.; 27: No. 10, 654-7(6 Sep 1971).

The formation of a shoulder in the high-frequency ultrasonic attenuation in superfluid helium under pressure is attributed to a restriction on the three-phonon process with thermal phonons. The restriction is proposed to follow from the pressure dependence of the phonon dispersion at zero temperature. The steep rise above the shoulder due to phonon–roton and roton–roton interactions also indicates large dispersion effects under pressure. (auth)

49821 ON THE MICROSCOPIC DERIVATION OF THE THERMODYNAMIC TWO-FLUID MODEL OF ^{4}He II. Hyland, G. H.; Rowlands, G. (Univ. of Warwick, Coventry, Eng.). Phys. Lett.; 36A: No. 3, 233-4(30 Aug 1971).

By defining the velocity of the normal component of He II operationally as the velocity of entropy transport, a relation is obtained between the superfluid density and that which appears naturally in microscopic theories, namely the condensate density. (auth)

Superconductivity

Refer also to abstracts 49460, 49470, 49471, 49534, and 50036.

49822 (AD-721664) SUPERCONDUCTING PROPERTIES OF TRANSITION METAL CARBIDES AND NITRIDES. Final Report.

XUM

Toth, L. E. (Minnesota Univ., Minneapolis. Dept. of Chemical Engineering and Materials Science). Mar 1971. 7p. (AFOSR-TR-71-856). NTIS.

During the last two years of this project research was continued on the superconducting and electrical properties of transition metal carbides and nitrides. Perhaps the most important achievement of the period was the continued development on thin films of niobium nitride. Additional studies were continued on the electron density of states in these materials as determined by low-temperature heat capacities and magnetic susceptibilities. Most of the work was focused on VC and TiC alloys. Research was also begun on augmented-plane wave calculations of the electron density of states in refractory materials such as carbides, nitrides, and borides. (auth) (USGRDR)

49823 (AD-722453) ULTRASONIC INVESTIGATION OF SUPERCONDUCTING PAIRS, SPIRAL SPINS, AND NUCLEAR SPIN WAVES. Final Report. Levy, Moises (California Univ., Los Angeles. Dept. of Physics). Jan 1971. 13p. (AFOSR-TR-3). NTIS.

Results of research on the following investigations are reported: properties of type-I and type-II superconductors by using ultrasonic techniques; electron–phonon interaction for transverse waves when the electromagnetic skin depth is comparable to the ultrasonic wavelength; interaction of nuclear spin waves with transverse ultrasonic waves; spin–phonon interaction in the spin spiral phase of rare earth metals in presence of an external magnetic field. (auth) (USGRDR)

49824 (IPP-4/84) STABILITY EVALUATION OF Nb_3Sn SUPERCONDUCTIVE TAPE IN A HELIUM GAS ENVIRONMENT. Amenda, W.; Martinelli, A. P. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Apr 1971. 18p. (CONF-710811-1). Dep. NTIS (U. S. Sales Only).

From thirteenth international congress of refrigeration; Washington, D. C. (27 Aug 1971).

The stability behavior of Nb_3Sn superconductive tape is studied in a variable temperature cryostat where the helium gas pressure is varied between about 20 and 1000 torr and the temperature between 4.2 and 20°K. The $I_c(H)$ short sample characteristic is measured at different gas pressures and temperatures. Magnetization measurements are also made for stacks of discs punched from Nb_3Sn tape. The temperature of the sample is observed during the whole magnetization cycle, particularly during and after the occurrence of flux jumps. The influence of the time variation of H and T on the magnetic stability of the sample is observed. Small samples inductively wound in the form of pancakes are also measured with a preset value of transport current and superposed magnetic field. The measurements for the above three types of samples are repeated in liquid helium and the results are compared with those obtained in helium gas. The results, besides being of general interest, are particularly applied to the construction of the two levitated rings (60 and 120 cm in diameter) for the superconductive quadrupole being built at Garching. (auth)

49825 (N-71-21957) MAGNETIC FLUX FLOW IN A TYPE-II SUPERCONDUCTOR. Urban, Eugene Willard (National Aeronautics and Space Administration, Huntsville, Ala. George C. Marshall Space Flight Center). Mar 1971. 74p. (NASA-TN-D-6244). NTIS.

An experimental study was conducted to measure the flow of magnetic flux through the wall of a specimen of Nb–25% Zr and, thereby, to infer the magnetic induction and currents in the material. It was found that, if at some magnetic field the specimen were heated to above T_c and recooled, and then if the applied field were subsequently changed at a constant rate, the rate of flux flow into or out of the sample would increase linearly with time. If measured at a series of magnetic fields, the rates of these increases or the flow-rate slopes were found to be a smoothly increasing function of average applied field. Calculations based on eight published critical-current-density models did not satisfactorily explain these observations. It was found, however, that an empirical current-density model did give excellent agreement with the measured flow-rate behavior. The experimental and analytical results are described, and the new critical-current-density model is compared with earlier ones. (auth) (STAR)

49826 (NYO-2391-132) STRONG-COUPLING PARAMETERS IN SUPERCONDUCTING In–Pb ALLOYS. Report No. 1597. Braendli, G.; Trofimenkoff, P. N. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Jul 1971. 10p. Dep. NTIS.

Far-infrared measurements of the energy gap in In–Pb alloys were performed. Results indicate that neither of two proposed relationships between $2\Delta/kT_c$ and T_c/θ_D is adequate. (auth)

49827 OBSERVATION OF AN ANOMALY IN TUNNELING THROUGH Si–Pb JUNCTIONS. Tsui, D. C. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Lett.; 27: No. 9, 574-6 (30 Aug 1971).

It was observed that the normalized tunnel conductance $(dI/dV)_S/(dI/dV)_N$ of Si/Pb junctions shows a strong dependence on the electron concentration of the bulk Si electrodes. The phonon-induced structure in the tunneling density of states of superconducting Pb is enhanced in the data with Pb positively biased and is suppressed in the data with Pb negatively biased. These enhancement and suppression effects increase with decreasing electron concentration in Si. (auth)

49828 ULTRASONIC INVESTIGATION OF SUPERCONDUCTING PROPERTIES INDUCED BY PROXIMITY EFFECTS. Kraetzig, E. (Philips Forschungslaboratorium, Hamburg). Solid State Commun.; 9: No. 14, 1205-9(15 Jul 1971).

From the ultrasonic surface wave attenuation of Cu/Pb–, Ag/Pb– and Al/Pb–double layers the number of Cooper pairs which leaked from the superconductor Pb into the normal metal is determined. The comparison with theory allows an estimate of the electron interaction parameter $N(O) \cdot V$ in the normal metal. (auth) (UK)

49829 SURFACE DENSITY OF NORMAL METAL IN THE INTERMEDIATE STATE OF SUPERCONDUCTING ALUMINUM. Wilkinson, G. A. (Univ. of Pittsburgh). Phys. Rev., B; 4: No. 7, 2174-8(1 Oct 1971).

Surface-impedance measurements made at 0.5 MHz on the intermediate state of aluminum indicate an increased fraction of normal metal near the surface as compared with the bulk. This result confirms Landau's prediction of the surface structure in the intermediate state and suggests a similar interpretation for Pippard's early observation of the surface resistance of tin at 10 GHz. Surface-impedance techniques are thus seen to provide accurate information on domain broadening near the surface and to corroborate the effective-field reduction there suggested qualitatively by bismuth-probe and magneto-optic methods. (auth)

49830 FLUX-FLOW AND FLUCTUATION EFFECTS IN GRANULAR SUPERCONDUCTING FILMS. Horn, P. M.; Parks, R. D. (Univ. of Rochester, N. Y.). Phys. Rev., B; 4: No. 7, 2178-85(1 Oct 1971).

Results are reported on the flux-flow state in granular aluminum films. Anomalously small values of depinning current are reported and attributed to the fact that the temperature-dependent coherence length is appreciably larger than the grain size in these films. Near T_c, the energy dissipated in vortex flow D ($D \propto d\rho_f/dH$, where ρ_f is the flow resistivity) was found to vary exponentially with temperature. This anomalous temperature dependence suggests that the major source of energy dissipation in this regime is the interaction of the vortex current fields with thermodynamic fluctuations. For sufficiently large values of $R_\square^N/\epsilon$ [$R_\square^N$ = normal-state resistance per square and $\epsilon = (T_c - T)/T_c$], the ρ_f-vs-H curves were found to be nonlinear in a manner not reported before in conventional flux-flow experiments. This curvature is attributed to the above-mentioned interaction between the vortices and fluctuations. (auth)

49831 SHARPENING OF THE RESISTIVE TRANSITION OF A SUPERCONDUCTOR WITH THE ADDITION OF PARAMAGNETIC IMPURITIES. Craven, R. A.; Thomas, G. A.; Parks, R. D. (Univ. of Rochester, N. Y.). Phys. Rev., B; 4: No. 7, 2185-9(1 Oct 1971).

Evidence is presented demonstrating that the addition of magnetic moments to a superconductor suppresses the Maki–Thompson contribution to the fluctuation conductivity. Measurements of the resistive transition of aluminum films with erbium impurities exhibit a sharpening of the transition with increasing impurity concentration which can be explained quantitatively using Thompson's scheme for regularizing the Maki–Thompson conductivity diagrams. (auth)

49832 DESTRUCTION OF SUPERCONDUCTIVITY BY LASER LIGHT. Testardi, L. R. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., B; 4: No. 7, 2189-96(1 Oct 1971).

Superconductivity is destroyed by laser light in Pb films of thickness comparable to the optical penetration depth δ and less than the superconducting coherence length ξ. Thermal effects, which have been independently determined, cannot account for this. For films of thickness greater than δ and ξ, only the thermal effect is observed. In a proposed explanation it is shown that the electron gas may be heated from 3 to 18°K above the lattice temperature by the light absorption in these experiments. (auth)

49833 ENCHANCEMENT OF SUPERCONDUCTIVITY IN RAPIDLY QUENCHED SAMPLES OF ALUMINUM ALLOYS.

Babic, E.; Krsnik, R.; Leontic, B.; Zoric, I. (Univ. of Zagreb). Fizika (Zagreb); 2: Suppl. 2, 3.1-5(1970).

From International conference on metastable metallic alloys; Brela, Yugoslavia (28 Sep 1970). See CONF-700952.

The process of ultrarapid quenching was found to affect the transition temperature of a number of alloys. Transition temperatures, T_c, of up to 2.95°K were obtained in bulk samples of aluminum–copper alloy (containing 0.85 at. % of copper) that were subjected to the process of ultrarapid quenching in a rotating-mill device. This method of quenching was found suitable as it secures large thin samples that had undergone cooling rates from the melt of about 10^6 °K sec^{-1}. At the same time, conventionally prepared alloys (from the same melt) showed normal behavior expected from such an alloy. The rise in T_c is linked to the quenching speed and is proportional to the residual resistance observed. A possible explanation of the phenomenon is offered by evoking a phonon surface modes mechanism. (auth)

49834 DISLOCATION INERTIAL EFFECTS IN THE PLASTICITY OF SUPERCONDUCTORS. Granato, A. V. (Univ. of Illinois, Urbana). Phys. Rev., B; 4: No. 7, 2196-2201(1 Oct 1971).

It is shown that radiation damping is weak enough so that all dislocation segments in superconductors are underdamped at low enough temperatures. Consequently, a dislocation impinging on a barrier in the superconducting state overshoots its static-equilibrium position, exerting an additional force on the obstacle, thereby increasing the plasticity. The inertial model gives a quantitative account of available observations on the size of the effect and its dependence on temperature, magnetic field, deformation, and purity. (auth)

49835 TUNNELING IN THE NORMAL-METAL/INSULATOR/SUPERCONDUCTOR GEOMETRY USING THE BOGOLYUBOV EQUATIONS OF MOTION. Griffin, Allan; Demers, Jacques (Univ. of Toronto). Phys. Rev., B; 4: No. 7, 2202-8(1 Oct 1971).

The quasiparticle (or thermal current) transmission probability W(E) for excitations going from a normal to a superconducting region through an oxide layer (N/I/S geometry) is calculated from first principles using the Bogolyubov–de Gennes equations of motion. The transmission probability $\overline{W}(E)$ is also worked out for electrical currents. For thick oxide layers ($W_{NN} \ll 1$), it is found that both W(E) and $\overline{W}(E)$ are given by $W_{NN}E/E(E^2-\Delta^2)^{1/2}$ for $E > \Delta$. This is in agreement with the tunneling Hamiltonian approach. In the opposite limit of no oxide layer ($W_{NN} = 1$), it is found that W(E) goes smoothly over into the expression obtained by Andreev for N/S junctions. On the other hand, $\overline{W}(E)$ reduces to unity, as expected. All the results are for sharp interfaces. (auth)

49836 TRANSITION TEMPERATURE OF NARROW-BAND SUPERCONDUCTORS. Appel, J. (Gulf General Atomic Co., San Diego, Calif.); Kohn, W. Phys. Rev., B; 4: No. 7, 2162-74(1 Oct 1971).

The equation for the vertex part of a Cooper pair is developed in the Wannier representation to highlight the atomic nature of the electrons responsible for superconductivity in narrow energy bands. For a nondegenerate band and a short-range interaction between two electrons at sites $\vec{n}_1$ and $\vec{n}_2$, the transition temperature T_c is determined by a small set of coupled integral equations in $\vec{n}_1 - \vec{n}_2$ and in the energy variable ω. With contact interaction, $\vec{n}_1 = \vec{n}_2$, only a single equation in ω remains as the defining equation for T_c. The solution has the Bardeen–Cooper–Schrieffer (BCS) form with an attractive interaction depending on a phonon Green's function in site space and with a repulsive interaction determined by the intra-atomic Coulomb integral U. The isotope effect is calculated as a function of U; the result can account for small negative or even positive effects, as observed in transition metals. For a degenerate band, the vertex part depends on the site variables $\vec{n}$ and on the orbital indices i, the latter denoting a set of localized orbitals which transform according to a degenerate representation of the crystal group. T_c is calculated in the contact model for a cubic Γ_{25}' band. The result contains the total density of states at the Fermi surface and the intraorbital and interorbital interactions weighted with factors $\frac{1}{3}$ and $\frac{2}{3}$, respectively. The lowering of T_c by long-range Coulomb interactions due to exchange effects is also briefly discussed. (auth)

49837 ELECTRONICS WITH SUPERCONDUCTING JUNCTIONS. Clarke, John (Univ. of California, Berkeley). Phys. Today; 24: No. 8, 30-7(Aug 1971).

The following topics are discussed: quantum phase effects, the Josephson effect, magnetometers, voltmeters and galvanometers, measuring e/h, generators and detectors, the junction as a frequency mixer, Josephson-junction thermometry, and computer elements. (M.H.R.)

49838 ABSORPTION OF ULTRASOUND IN TWO-ZONE SUPERCONDUCTORS WITH NONMAGNETIC IMPURITIES. Moskalenko, V. A.; Golub, A. A.; Kon, L. Z. (Inst. of Applied Physics, Kishinev, USSR). Fiz. Metal. Metalloved.; 30: No. 2, 289-94 (Aug 1970). (In Russian).

Calculations were made of coefficients a_s/a_n of absorption of ultrasound in superconducting- and normal-state two-zone superconductors with high concentrations of nonmagnetic impurities. The dispersion of the sound wave was not considered. (tr-auth)

49839 ELECTROMAGNETIC PROPERTIES OF SUPERCONDUCTORS WITH STRONG COUPLING. Medvedev, Yu. V. Fiz. Metal. Metalloved.; 30: No. 2, 235-41(Aug 1970). (In Russian).

General expressions for the critical field of supercooled superconductors with strong electron–phonon interactions are obtained. The behavior of the anomalous superconductor in a high-frequency field is examined. (tr-auth)

49840 VOLUME CHANGE BETWEEN NORMAL AND SUPERCONDUCTING ALUMINUM ABOVE 0.3K. Griessen, R.; Ott, H. R. (Eidgenoessische Technische Hochschule, Zurich). Phys. Lett.; 36A: No. 2, 113-14(16 Aug 1971).

The magnetostriction of an Al single crystal was measured between 1.2 and 0.3°K. It was found that the length changes may be expressed approximately by $(l_s - l_n)/l_s = (6.2 - 5.5\,t^2 - 0.7\,t^4) \times 10^{-3}$. This is in fair agreement with data on the pressure dependence of the critical field. (auth)

49841 SURFACE IMPEDANCE OF SUPERCONDUCTING METALS AT HIGH FREQUENCIES. Septier, A. (Paris Univ., Orsay, France). pp 1089-1106 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The historical background and the fundamentals of superconductivity are given. The following topics are discussed: the surface impedance of metals at very low temperatures, macroscopic theories of high-frequency conductivity in superconductors, recent theories of the rf conductivity, and the use of superconductors at uhf. (France)

49842 EFFECT OF SOURCE RESISTANCE ON CURRENT-VOLTAGE CHARACTERISTICS OF SUPERCONDUCTING WEAK LINKS. Warman, J. (State Univ. of New York, Stony Brook); Blackburn, J. A. Appl. Phys. Lett.; 19: No. 3, 60-2(1 Aug 1971).

The effect of finite source resistance on the computed current–voltage characteristics of superconducting weak links is considered for both capacitive and inductive devices. Hysteresis is found to vanish for a sufficiently small-source to shunt-resistance ratios. (auth)

49843 MEASUREMENTS OF THE STATIC PINNING OF MAGNETIC FLUX IN SUPERCONDUCTORS. Kaper, J. P.; Zweers, H. A.; Dekking, P.; Van Beelen, H. (Rijksuniversiteit, Leiden). Physica; 53: No. 1, 60-3(17 May 1971).

Results of measurements on the static pinning of magnetic flux in superconducting sheets of low κ value ($\kappa \lesssim 2$) are reported. The pinning force F is measured with a torsion balance. For all specimens the simple temperature dependence $F = F_0(1 - T/T_c)^2$ was found regardless of the ratio in which surface pinning and bulk pinning contribute to F. A detailed separation of the contributions to F arising from the different pinning mechanisms appeared not to be possible, due to insufficient knowledge of the metallurgical conditions of the pure and well-annealed, but polycrystalline specimens. (auth)

49844 SUPERCONDUCTIVITY IN INTERCALATED MOLYBDENUM DISULFIDE. Somoano, R. B.; Rembaum, A. (California Inst. of Tech., Pasadena). Phys. Rev. Lett.; 27: No. 7, 402-4 (16 Aug 1971).

Molybdenum disulfide was intercalated with sodium and potassium. Both natural crystals of molybdenite and synthetic crystals were used, and measurements made on the intercalated products indicate a superconducting transition temperature of ~1.3°K for sodium and ~4.5°K for potassium. (auth)

49845 INTENSE TUNABLE PHONON FLUORESCENCE IN SUPERCONDUCTORS. Narayanamurti, V.; Dynes, R. C. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Lett.; 27: No. 7, 410-13(16 Aug 1971).

The phonon fluorescence spectrum of superconducting Sn and $Pb_{0.5}Tl_{0.5}$ films pumped by a heat pulse is studied through the observation of resonance absorption by Sb donor levels in uniaxially compressed Ge. The spectrum consists primarily of a narrow band of phonons centered about the energy gap 2Δ (1.2 meV for Sn,

XUM

1.7 meV for $Pb_{0.5}Tl_{0.5}$). The power generated in this narrow band is at least hundreds of milliwatts. In the case of Sn the phonon energy has been tuned from 1.2 meV down to 0.7 meV by a magnetic field parallel to the plane of the film. (auth)

49846 QUANTUM INTERFERENCE EFFECTS OF A MOVING VORTEX LATTICE IN Al FILMS. Fiory, A. T. (Bell Telephone Labs. Inc., Murray Hill, N. J.). Phys. Rev. Lett.; 27: No. 8, 501-3(23 Aug 1971).

An experimental study is reported of steps induced in the flux-flow I–V characteristics of superconducting aluminum films by a superimposed rf current, whose frequency is a harmonic or subharmonic of the ratio of the vortex velocity and the lattice parameter. (auth)

49847 DISLOCATION INERTIAL MODEL FOR THE INCREASED PLASTICITY OF THE SUPERCONDUCTING STATE. Granato, A. V. (Univ. of Illinois, Urbana). Phys. Rev. Lett.; 27: No. 10, 660-4(6 Sep 1971).

A model is proposed to account for the increased plasticity found for superconductors entering the superconducting state. It is supposed that at low-enough temperatures in superconductors, inertial effects permit dislocations to overshoot their static equilibrium positions against obstacles and exert greater forces on the barriers. Quantitative agreement is found with experimental results for the temperature dependence of the stress drop. There is evidence that inertial effects contribute to the flow stress of nonsuperconductors. (auth)

49848 CONDUCTION PROCESSES IN POLYMERS. McCubbin, W. L. (Welsh Coll. of Advanced Tech., Cardiff, Eng.). J. Polym. Sci., Part C; No. 30, 181-93(1970).

From International symposium on macromolecular chemistry, Toronto, Canada (3 Sep 1968). See CONF-680966.

After reviewing the basics of conduction processes in linear polymers, superconducting polymers are briefly discussed. The author feels that attempts to construct linear polymers that will exhibit superconductivity are not based on sound theoretical arguments and that efforts at finding a polymer with metallic conductivity appear doomed to failure if only linear polymers are investigated. Many types of 3D structures that might exhibit sufficient conductivity would not be expected to have desirable mechanical properties. 29 references. (L.M.T.)

49849 LINEAR AND NONLINEAR V–I PLOTS IN VORTEX FLOW OF THIN FILMS. Ogushi, T.; Takayama, T.; Shibuya, Y. (Kyushu Univ., Fukuoka). Phys. Lett.; 36A: No. 3, 247-8(30 Aug 1971).

Linear and nonlinear V–I plots, which appear intrinsically in the vortex flow measurement on superconducting thin films, are discussed. Nonlinearity in V–I plots seems to become remarkable for the vortex lattice spacing $a(<2 \times 2\lambda^2/d)$. (auth)

49850 EFFECTS OF PAULI PARAMAGNETISM ON SUPERCONDUCTING FLUCTUATIONS. Aoi, Koya (Institut Max von Laue–Paul Langevin, Garching, Ger.). Z. Phys.; 246: No. 1, 71-83(1971).

The effects of the Pauli paramagnetism on the excess conductivity σ^{fl} due to fluctuations of the superconducting order parameter are discussed. A formula for σ^{fl} for a thin film placed in a magnetic field of an arbitrary orientation α was derived. It was found that σ^{fl} has a universal behavior as a function of some parameter ρ which depends on α and $\Delta H \equiv H - H_c$. If ΔH is kept constant and σ^{fl} is measured as a function of α, in the absence of the Pauli paramagnetism σ^{fl} is maximum when the field is parallel to the film and is minimum when the field is perpendicular. But in high-field superconductors, due to the effect of the Pauli paramagnetism, σ^{fl} becomes maximum at some intermediate-field orientation. The excess conductivity in magnetic alloys in which impurity spins are aligned by an external magnetic field is also discussed. It was shown that in this case one should expect, with certain strengths of the external field, excess conductivity which is nonmonotonic in temperature. (auth)

Equipment and Devices

Refer also to abstracts 49070, 50298–50316, 50431–50435, 50439, and 50440.

49851 (NP-18978) SELECTION OF AN OPTIMAL COOLING SYSTEM FOR SUPERCONDUCTING MAGNETS. Dinaburg, L. B.; Kalinin, V. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Leningrad). 1970. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

Problems of the selection of cooling systems for superconducting magnets that are optimal from the viewpoint of power consumed for compensation of heat inflow to liquid helium are discussed. Estimated data are given on the amount of consumed power by liquefied, refrigerative, and intermediate (combined) cycles of a mean-pressure cooling installation. Based on thermal characteristics of currently used thermal insulating materials and data on consumed power for the cooling cycles, calculations are made for manufacture of various cooling systems: a cryogenic installation and a cryostat with a wide range of values of heat inflows along thermal insulating barriers and thermal bridges. A comparative analysis of data obtained is given. (auth)

49852 FREQUENCY DEPENDENCE OF SUPERCONDUCTING CAVITY Q AND MAGNETIC BREAKDOWN FIELD. Rabinowitz, Mario (Stanford Univ., Calif.). Appl. Phys. Lett.; 19: No. 3, 73-6(1 Aug 1971).

A theoretical explanation is given to account for the unexpected observation that L- and S-band Nb superconducting cavities were found to have lower Q and lower magnetic breakdown field than those of the higher X-band frequencies. Both effects can be related to the trapping of magnetic flux in the cavity walls. The frequency dependence arises from the frequency dependence of the resistivity of oscillating fluxoids. Calculations based on this model are in agreement with experimental observations. (auth)

49853 AC LOSSES IN SUPERCONDUCTING SYNCHROTRON MAGNETS. Brechna, H.; Ries, G. (Univ., Karksruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 639-40(Jun 1971).

From National particle accelerator conference; Chicago, ILL+ (1 Mar 1971). See CONF-710308.

A. C. losses of composite conductors and synchrotron magnets are given. A new equation based on a skin-effect assumption is presented, which shows that the generally accepted self field calculations yield too high values. Results from loss equations are compared to a few tests on small solenoids. (auth)

49854 SATURATION EFFECTS IN HIGH-FIELD SUPERCONDUCTING MAGNETS. Parzen, G.; Jellett, K. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 646-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

It appears desirable to surround a high-field superconducting dipole magnet with an iron shield. This gives about 45% more magnetic field for the same total current, and reduces the stored energy considerably. The leakage magnetic field is also reduced. Saturation of the iron shield at high fields introduces sextupole fields in the median plane which, although small, can introduce serious nonlinear effects in the particle orbits. The size of the sextupole fields can be reduced by proper choice of the thickness of the iron shield. Computer studies have shown that there exists an iron shield thickness which will make the sextupole field vanish at a particular field. This critical thickness of the iron shield is not too far from presently considered thicknesses which are based on other considerations. (auth)

49855 TEMPERATURE DEPENDENCE OF CRITICAL CURRENT IN DIFFUSION PROCESSED ^3NbSn. Haller, T. R.; Belanger, B. C. (General Electric Co., Schenectady, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 671-3 (Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The critical current in diffusion processed Nb_3Sn tape manufactured by the General Electric Company was measured in the temperature range 4.2 to 18.0°K in magnetic fields up to 100 kG. Samples were clamped between two copper blocks (each temperature controlled by separately energized heaters) and placed in an evacuated can. Carbon resistance thermometers displaced axially along the sample and mounted in the copper blocks on alternate sides of the sample permitted measurement of the absolute temperatures and detection of any temperature gradients. Thus heaters could be balanced to provide uniform temperature across the sample and any lead heating was readily detected. The thermometers were calibrated in the presence of magnetic fields to ensure accuracy to at least ±0.1°K. The data are in general agreement with those of Aron and Ahlgren where overlap occurs but exhibit a somewhat stronger field dependence particularly at low fields. (auth)

49856 FLUX PUMPS FOR USE AT 60 Hz. Britton, R. B. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 681-2(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

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Many superconducting devices now being built require currents of a thousand or more amperes. When the currents needed are dc and large compared with the heat leakage into the cryostat from sources other than the electrical leads, it may be advantageous to use a flux pump or ac-to-dc converter within the dewar for powering the device. The flux pumps described convert low current-high voltage ac power into high current-low voltage dc power. Pumps designed to operate in the 500 to 1200 A range at 5 to 20 W will be discussed. (auth)

49857 DEVELOPMENT OF A NEW PRACTICAL HIGH-T_c SUPERCONDUCTING CONDUCTOR MATERIAL. Kohr, J. G. (Massachusetts Inst. of Tech., Cambridge, Mass.); Strauss, B. P.; Rose, R. M. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 716-17(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Conductor material based on the high-T_c beta tungsten superconductor Nb_3Al has been developed. The available configurations are relatively convenient and low in cost and may be made into fully transposed cable. Transition temperatures are 18.5 to 18.7°K. Critical current density vs. transverse field data for flat and bent short specimens are presented. (auth)

Plasma and Thermonuclear Physics

Refer also to abstracts 48690 and 50276.

49858 (IPP-6/93) TOKAMAK BIBLIOGRAPHY. Green, B. J. (comp.) (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Mar 1971. 124p. Dep. NTIS (U. S. Sales Only).

This listing includes 604 references on the following: dynamic equilibrium and stability, feedback stabilization, toroidal confinement, diagnostics, plasma injection, plasma heating, transport processes, z pinches, and fast toroidal pinches. (M.O.W.)

49859 (MATT-Q-28) ANNUAL REPORT, JANUARY 1-DECEMBER 31, 1970. (Princeton Univ., N. J. Plasma Physics Lab.). Jul 1971. Contract AT(30-1)-1238. 139p. Dep. NTIS.

Separate abstracts were prepared for five sections. (M.O.W.)

For abstracts of individual sections see: 49864-49866, 49881, and 49922.

49860 (UCRL-73158) FUSION POWER. Post, R. F. (California Univ., Livermore. Lawrence Radiation Lab.). 26 Apr 1971. 25p. (CONF-710436-1). Dep. NTIS.

From Symposium on energy for the future; Washington, D. C. (26 Apr 1971).

A review of controlled thermonuclear research to date is given. The prospects of open and closed systems and direct energy conversion are discussed in general terms. (M.O.W.)

Confinement and Heating

Refer also to abstract 49930.

49861 (COO-2081-3) PARTICLE CONTAINMENT IN MIRROR TRAPS IN THE PRESENCE OF FLUCTUATING ELECTRIC FIELDS. Aamodt, R. E. (Colorado Univ., Boulder. Dept. of Astro-Geophysics). Apr 1971. Contract AT(11-1)-2081. 12p. Dep. NTIS.

Particle motion in MHD stable magnetic mirrors and the high-frequency electric fields characteristic of the collective modes of such a system is shown to be restricted by two simple constraints. These constraints, which reduce to the usual magnetic moment and kinetic energy in the absence of fluctuating fields, dictate that while even small-amplitude waves induce large magnetic moment excursions, the particle containment properties of the trap are not greatly reduced by the fluctuations. (auth)

49862 (COO-2081-4) MIRROR CONTAINMENT WITH LOW FREQUENCY SHORT-WAVE LENGTH FLUCTUATIONS. Aamodt, R. E. (Colorado Univ., Boulder. Dept. of Astro-Geophysics). Jun 1971. Contract AT(11-1)-2081. 8p. Dep. NTIS.

Low-frequency fluctuations having long wavelengths along, and arbitrary wavelengths in one direction perpendicular to, an external magnetic mirror field are shown to only weakly affect particle containment in the mirror trap. It is shown that a critical level of fluctuations exists, below which essentially no losses occur, and above which nonexpandable, nonlinear transitions in phase space induce only weak diffusion. (auth)

49863 (IPP-4/20) REMARK ON TRAPPED PARTICLE PINCH IN A TOKOMAK. Mayer, H. M.; Puri, S. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Mar 1971. 7p. Dep. NTIS (U. S. Sales Only).

Trapped particle pinch in a Tokamak is shown to be directly related to flux surface concentration. Study of flux surface motion allows an accurate estimate of particle drift in arbitrary axisymmetric geometries. The trapped-particle pinch velocity is compared with the numerical computation of the particle trajectory in a Levitron. (auth)

49864 (MATT-Q-28, pp 1-34) TOROIDAL CONFINEMENT EXPERIMENTS. (Princeton Univ., N. J. Plasma Physics Lab.). In Annual report, January 1-December 31, 1970.

Research work is reported on the Model ST Tokamak, levitated superconducting-ring spherator, the FM-1 spherator, and an adiabatic toroidal compression experiment. Data are given of plasma parameters for most of the studies. (M.O.W.)

49865 (MATT-Q-28, pp 35-48) THEORY. (Princeton Univ., N. J. Plasma Physics Lab.). In Annual report, January 1-December 31, 1970.

The review of the theoretical program is divided into four sections: (1) the theory of tokamaks and stellarators, (2) basic plasma physics, (3) computer simulation of plasmas, and (4) astrophysics. Brief discussions are given for each area. (M.O.W.)

49866 (MATT-Q-28, pp 54-63) RADIO-FREQUENCY HEATING. (Princeton Univ., N. J. Plasma Physics Lab.). In Annual report, January 1-December 31, 1970.

Plans for ion-cyclotron heating on the ST Tokamak and for lower-hybrid heating on the ST Tokamak are discussed. Descriptions are also given of small machine experiments on magnetic pumping with a strong spatial gradient, of parametric heating near the electron plasma frequency, and of a new rf ion source. (M.O.W.)

49867 (MATT-Trans-106) MEASUREMENT OF THE DIFFUSION LIFETIME OF THE PLASMA IN THE TOKAMAK-3 MACHINE BY THE INJECTION OF NEUTRAL HYDROGEN. Gorbunov, E. P.; Mirnov, S. V.; Parfenov, D. S. (Institut Atomnoi Energii, Moscow (USSR)). Translation of report IAE-2064. 26p. Dep. NTIS.

Experiments are described that deal with the impulse injection of a neutral gas during the discharge process in the Tokamak-3 machine. Measurement of the electron concentration was carried out by multichord probing with 2-mm waves. The flux of neutral gas from the chamber walls and from the diaphragm was determined from measurements in three directions of the intensity of a hydrogen spectral line. The diffusion lifetime lies within the limits 20 to 30 msec, and the cessation of the drop in electron concentration in the middle stage of the discharge is not associated with an increase in the flux of neutral gas but with the improvement in containing the plasma. The fluxes from the diaphragm and the chamber walls are compared. The diffusion and energy times are contrasted. (auth)

49868 ANOMALOUS RESISTANCE AND OHMIC HEATING OF THE MAGNETIZED PLASMA IN A STELLARATOR. Burchenko, P. Ya.; Volkov, E. D.; Rudakov, V. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 2, 323-5(Aug 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 2, 428-30(Feb 1971).

An experimental study of the anomalous resistance and ohmic heating in a Sirius stellarator is described. The ratio of the Coulomb conductivity, calculated from the temperature (determined from diamagnetic measurements), to the experimental temperature is shown to be a linear function of the ratio of the applied electric field to the critical Dreicer field. The thermal velocity of the electrons is proportional to the current velocity. The results are compared with theory. (auth)

49869 ANOMALOUS ELECTRON THERMAL LOSSES IN TOKAMAKS. Widner, M. M.; Dory, R. A.; Hogan, J. T. (Oak Ridge National Lab., Tenn.). Phys. Lett.; 36A: No. 3, 217-18 (30 Aug 1971).

Anomalous electron heat transport in tokamaks is investigated by computer simulation, considering neoclassical and empirical models. The results from a modification of an empirical model given by Artsimovich are most consistent with experimental data. (auth)

49870 PLASMA DIFFUSION DUE TO WEAK NONAZISYMMETRY. Liu, Chuan Shen (Gulf General Atomic Co., San Diego, Calif. Univ. of California, Los Angeles). Phys. Rev. Lett.; 27: No. 7, 399-401(16 Aug 1971).

Plasma diffusion due to static, nonaxisymmetric perturbations

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of magnetic or electric field is analyzed in the low collision-frequency region. The diffusion coefficient is found to be proportional to the fraction of the particles with slow drift and can significantly exceed classical diffusion. (auth)

49871 PLASMA HEATING WITH AN ELECTRON BEAM. Averin, V. G.; Bezmel'nitsyn, V. N. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 3, 396-9(Sep 1971).
Translated from Zh. Tekh. Fiz.; 41: No. 3, 510-14(Mar 1971).

It is observed that in the penetration of an electron beam (I = 0.5 to 10 A, U = 6 to 14 kV) through a cold plasma of controlled density ($n_0 = 5 \times 10^{10}$ to 2×10^{12} cm^{-3}) located in a magnetic trap there is a resonant plasma density for which the heating is maximized. The resonant density is proportional to the electron energy. It is shown that the two-stream instability in a bounded plasma is due to the Cherenkov effect. (auth)

Diagnostics

49872 (AD-721090) SPLIT-IMAGE LINE-REVERSAL TECHNIQUE FOR SHOCK TEMPERATURE STUDIES. Guttman, A.; Tate, E. (General Electric Co., Philadelphia, Pa. Space Div.). 20 Jul 1970. Contract N00014-70-C-0321. 35p. (ONR-TR-16). NTIS.

A new experimental technique was used to obtain line reversal temperature measurements behind reflected shocks in a cesium-seeded MHD shock tube. Utilizing a compact single-filament, split-image arrangement, the apparatus is arranged in line and requires only one set of optics to accommodate both high- and low-temperature channels. Results in the reflected shock region of a Mach 3 shock were obtained by means of the blue resonance line of the principle series of cesium (lambda 4555A). Temperatures were found to be a few percent lower than given by the Rankine–Hugoniot relations. The difference is attributed to the heat of vaporization of the cesium particles and subsequent ionization. Electron densities based on these temperature measurements were combined with simultaneous free–bound continuum radiation measurements and reported recombination cross sections to yield results consistent with equilibrium calculations. (auth)

49873 (IPP-1/116) DETERMINATION OF THE PRODUCTS FROM ELECTRON DENSITY AND MAGNETIC FIELD IN A SMALL THETA PINCH BY POLARIMETRY AT 633 NM. Glock, E. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Apr 1971. 35p. (In German). Dep. NTIS (U. S. Sales Only).

The product of electron density and axial magnetic field in a 5-kJ θ pinch was measured by the Faraday rotation of a He–Ne laser beam at 633 nm. With 10-mW laser output at disposal and ~20-ns rise time in the detector channel, a signal-to-noise ratio of unity was attained with $n_e \cdot B \cdot l = 10^{21}$ gauss · cm^{-2}, corresponding, e.g., to 100 gauss in 1-m coil length with $n_e = 10^{17}$ cm^{-3}. The measurements are consistent with supplementary flux measurements and smear photographs. Some of the ideas prevailing about the phenomena in a θ pinch could not be confirmed. (auth)

49874 (KHFTI-70-71) USE OF DUAL ELECTRIC PROBES FOR MEASURING FLUCTUATIONS AND FLUCTUATING CURRENTS IN A TURBULENT PLASMA. Barkov, A. P.; Vasil'ev, M. P.; Pavlichenko, O. S.; Tereshchenko, F. F. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1970. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

The current collected by dual electric probes placed in a homogeneous plasma is given as a function of the plasma density, electron temperature, ion mass, and the potential difference between the probes in the plasma. It was found that at large voltage biases the current on the probe does not approach saturation, but is a linear function of the voltage bias. Good agreement with experiment is obtained by addition of another term to the volt–ampere characteristic equation. It is shown that the correct factor does not depend on the electron temperature and is proportional to the saturation current. The equations are further developed to give the average square of the current fluctuations on the probe as a function of the local temperature, particle density, and electric field. It is possible to judge the predominance of the variation in local temperature or particle density as a function of the voltage between the two probes. Measured and calculated values of particle and energy fluxes in a negative discharge were compared and found to be in good agreement. Anomalous transverse diffusion in a negative discharge is associated with plasma instability. (TTT)

49875 (N-70-41180) A THEORETICAL STUDY OF HALL PARAMETER MEASUREMENTS WITH AN IMMERSIBLE THREE-COIL CONDUCTIVITY/VELOCITY PLASMA PROBE. Final Report, October 1, 1969–April 1, 1970. Vendell, Edward (Utah State Univ., Logan. Dept. of Mechanical Engineering). 12 Jun 1970. 13p. (NASA-CR-113866). NTIS.

The purpose of this study is to determine if a three-coil plasma probe can be used to take meaningful conductivity and velocity data measurements in a plasma when the only externally applied field is a large dc magnetic field. (auth) (STAR)

49876 (N-71-22585) THEORETICAL AND EXPERIMENTAL STUDIES OF THE NATURE AND CHARACTERISTICS OF SPACE-RELATED PLASMA RESONANCE PHENOMENA. Final Report, July 1, 1969–June 30, 1970. Crawford, F. N. (Stanford Univ., Calif. Inst. for Plasma Research). Oct 1970. 42p. (NASA-CR-117844; SU-IPR-399; SAR-10). NTIS.

The space plasma experiments involving Alouette resonances and the diagnostic techniques developed are discussed. Possible applications to the measurement of electron density and temperature and local magnetic field strength are included. The existence and mechanism of very long and delayed ratio echoes were investigated, as well as the resonant nonlinear interaction of two signals at frequencies ω_1 and ω_2 to give a radiated signal at frequency $\omega_1 \pm \omega_2$. (STAR)

49877 INTERFEROMETER FOR MEASURING REFRACTIVE INDEX OF A TIME-VARYING PLASMA. Korobkin, V. V.; Pyatnitskii, L. N. (Power Engineering Inst., Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 2, 336-7(Aug 1971).
Translated from Zh. Tekh. Fiz.; 41: No. 2, 440-2(Feb 1971).

A highly sensitive interferometer system is described for measuring the refractive index of a plasma with rapidly and slowly varying parameters. In addition to a laser that generates probing radiation, and a Fabry–Perot interferometer, the system contains an auxiliary laser that operates at a different frequency; this provides compensation for instabilities of the relative optical lengths of the probing laser and the interferometer cavities. The system permits the measurement of electron densities down to 10^{10} cm^{-3} for a plasma 1 cm long and 10^8 cm^{-3} for a plasma 1 m long. (auth)

49878 TWO-FREQUENCY SINGLE-EXPOSURE PLASMA HOLOGRAPH. Ignatov, A. B.; Komissarova, I. I.; Ostrovskaya, G. V.; Shapiro, L. L. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 2, 315-19(Aug 1971).
Translated from Zh. Tekh. Fiz.; 41: No. 2, 417-23(Feb 1971).

The two-frequency single-exposure holograph is described in detail, and preliminary results obtained in plasma diagnostics are given. The use of this method in plasma diagnostics makes it possible to determine the electron density from one single-exposure interference pattern without corrections for heavy particles. (auth)

49879 ELECTRON TEMPERATURE, DENSITY, AND CONDUCTIVITY OF ELECTRODELESS RF DISCHARGE IN ARGON. Paithankar, A. S.; Jayakumar (Bhabha Atomic Research Centre, Trombay, India). pp 301-6 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).
From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

49880 SURFACE WAVE PROBE METHOD FOR DETERMINING ELECTRON DENSITY IN A PLASMA. Maiti, J. N.; Basu, J. (Saha Inst. of Nuclear Physics, Calcutta). pp 307-11 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).
From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

Kinetics (General)

49881 (MATT-Q-28, pp 49-53) SMALL MACHINE EXPERIMENTS. (Princeton Univ., N. J. Plasma Physics Lab.).
In Annual report, January 1–December 31, 1970.

Experiments were carried out on small linear Q machines to study feedback stabilization, anomalous resistivity, nonlinear wave–wave and wave–particle scattering, the approach of an unstable plasma to the quasi-linear steady state, the Kelvin–Helmholtz instability, current-driven drift waves, and other topics. Brief discussions are given for each. (M.O.W.)

49882 (NP-18972) THEORETICAL AND EXPERIMENTAL STUDIES OF DIRECT, HIGH-CURRENT DISCHARGES IN VACUUM. Aleksandrov, A. F.; Zosimov, V. V.; Rukhadze, A. A.; Savoskin, V. I.; Timofeev, A. A. (Akademiya Nauk SSSR, Mos-

cow. Institut Fiziki). Jun 1971. 51p. (In Russian). Dep. NTIS (U. S. Sales Only).

High-current discharges can be used as powerful sources of radiation for "pumping" lasers (optical quantum generators). Hence, a more careful look at theory and experiment is justified. These discharges can be divided into two classes: (1) vacuum discharges, and (2) high-current discharge in a gaseous medium such as is caused by passing a high current through a thin metal wire. The theory is developed for the equilibrium distribution of density, velocity, magnetic field and temperature in transparent, nontransparent, and "gray" discharges. Confirmation of the theoretical conclusions was sought and found by taking spectral measurements on plasmas formed by exploding silver wires electrically in quartz vessels. Good agreement between theory and experiment was found. (TTT)

49883 FUSION TORCH: A NEW APPROACH TO POLLUTION AND ENERGY USAGE. Eastlund, Bernard J.; Gough, William C. (Atomic Energy Commission, Washington, D. C.). Chem. Eng. Progr., Symp. Ser.; 66: No. 104, 175-86(1970).

A new concept is discussed for the handling of large volumes of solid wastes in the future. The energy and material balance for processing U. S. municipal wastes in the year 2000 via this concept is compared with that for advanced incineration. Background discussion of the properties of a fusion plasma and a future fusion power system is given. The "Fusion Torch" concept offers the possibility of accomplishing a complete closing of the cycle from use to reuse. Ultrahigh-temperature ionized gas plasmas, available now in fusion experiments and on a much larger scale in future controlled fusion reactors, could be used to reduce any material to its basic elements for separation. (auth)

49884 ELECTRIC POTENTIAL DISTRIBUTION IN A MAGNETOACTIVE PLASMA. Konstantinov, S. G.; Tsel'nik, F. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 3, 382-5(Sep 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 3, 493-6(Mar 1971).

The radial distribution of the electric potential in a Penning-type discharge was obtained from measurements of the time of flight of SF_6^- ions as a function of their initial energy. (auth)

49885 ION ENERGY DISTRIBUTION IN TOROIDAL DEVICES. Gladkovskii, I. P. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 3, 400-3(Sep 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 3, 515-19(Mar 1971).

It is shown that the distributions of fast ions in plasmas in various toroidal devices can be closely approximated by the function $dn/dv \sim \exp(-v/v_0)$ with the value of the constant v_0 being (3 to 9)$\times 10^6$ cm/sec. This distribution is in qualitative agreement with the assumption of statistical acceleration of ions in a plasma with moving magnetic field inhomogeneities. In the Alpha device, in which the characteristic of these inhomogeneities is well known, the possibility of such ion acceleration is confirmed by calculation. (auth)

49886 ION MOTION IN A DOUBLE-LENS ACCELERATOR WITH CLOSED ELECTRON DRIFT. Zubkov, I. P.; Kislov, A. Ya.; Lebedev, S. V.; Morozov, A. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 3, 409-14(Sep 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 3, 526-33(Mar 1971).

Ion trajectories in a double-lens accelerator with closed electron drift are calculated, and the ion current density distribution in the accelerator channel is measured. The electron temperature and the ionization region of the working material (hydrogen) are determined. (auth)

49887 EFFECT OF INTERRUPTION TIME ON PLASMOID ACCELERATION IN AN INDUCTIVE ENERGY-STORAGE ACCELERATOR. Belan, N. V.; Mashtylev, N. A.; Panachevnyi, B. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 3, 433-5(Sep 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 3, 559-62(Mar 1971).

Plasmoid acceleration is discussed for an accelerator with inductive energy storage; it is assumed that a self-sustained arc is produced in the switching system. The plasmoid acceleration process is characterized by two stages: in the first the acceleration is due to power from the source; in the second the acceleration is due to the stored energy. A faster interruption time yields higher efficiency in acceleration in injectors of this kind. (auth)

49888 ELECTRON ENERGY DISTRIBUTION FUNCTION IN A HIGH-FREQUENCY INDUCTION DISCHARGE. Eroshchenkov, E. K.; Malkin, O. A. (Moscow Engineering Physics Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 3, 510-12(Sep 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 3, 654-6(Mar 1971).

Using double differentiation of the volt–ampere characteristics obtained by an asymmetric double probe, one obtains the electron energy distribution in a high-frequency induction discharge. The discharge is operated in argon and air at pressures of 0.02 to 0.5 torr. In argon at pressures greater than 0.02 torr, a distribution function deviating markedly from a Maxwellian or Druyvesteyn distribution was observed. In air, the distribution function is approximately Maxwellian over the entire range of pressures. (auth)

Kinetics (Experimental)

49889 (AD-708161) RADIATION STUDIES OF ARC HEATED PLASMAS. Final Technical Report, September 15, 1967–September 30, 1969. Morris, J. C.; Morris, R. U. (Avco Corp., Lowell, Mass. Applied Technology Div.). Jan 1970. Contract F33615-68-C-1081. 98p. (AVATD-207-69-CR; ARL-70-38). NTIS.

Results of an experimental and analytical program to determine the radiative properties of high-temperature high-density plasma are presented. The plasmas were produced in a mechanically constricted arc generator. (auth) (USGRDR)

49890 PLASMOID ACCELERATION IN AN INJECTOR WITH INDUCTIVE ENERGY STORAGE. Belan, N. V.; Mashtylev, N. A.; Panachevnyi, B. I. (Kharkov Aeronautical Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 2, 200-4(Aug 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 2, 266-71(Feb 1971).

The acceleration of a plasmoid in an injector with inductive energy storage is considered. Equations are obtained that describe the acceleration process when the storage device is fed from sources of direct and alternating current, both with the creation of a self-sustaining arc discharge in the switching system and with instantaneous opening of the charging circuit. With instantaneous opening of the charging circuit, the acceleration of the plasmoid is determined uniquely by the energy parameter; furthermore, an increase in the energy parameter leads to an increase in acceleration efficiency. (auth)

49891 INTENSITY AND SHAPE OF THE EMISSION LINES AT ELECTRON CYCLOTRON HARMONICS IN A PLASMA. Vasil'ev, M. P.; Kuznetsov, Yu. K.; Pavlichenko, O. S.; Starikov, V. N. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 2, 353-5(Aug 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 2, 457-60(Feb 1971).

A study was made of the effects of magnetic field homogeneity on the spectrum and radiated power at harmonics of the electron cyclotron frequency for a plasma column in a reflex discharge. It was found that the radiation is due to a cyclotron instability. (auth)

49892 PRELIMINARY EXPERIMENT ON THE CURRENT SUSTAINING IN A MAGNETIZED TOROIDAL PLASMA. Hirano, K.; Matsuura, K.; Mohri, A. (Nagoya Univ., Japan). Phys. Lett.; 36A: No. 3, 215-16(30 Aug 1971).

Traveling rf fields are effective in inducing dc plasma current along a toroidal magnetic field. Whistler waves are found to play an important role for the mechanism. Bunched electrons moving with the wave are observed. (auth)

49893 DIFFUSION AND INSTABILITY OF PLASMA IN A COLD CATHODE PIG DISCHARGE. Chatterjee, A. K.; Bose, D. K.; Sen Gupta, S. N. (Saha Inst. of Nuclear Physics, Calcutta). pp 312-14 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

Kinetics (Theoretical)

Refer also to abstracts 49630 and 49664.

49894 (FRNC-TH-38) STUDY OF THE ELECTRON ENERGY DISTRIBUTION FUNCTIONS IN A WEAKLY IONIZED GAS. Cortina, Argentine Marinette (Toulouse Univ. (France)). 1971. 133p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The range of validity of the equation describing the balance between energy gains and energy losses in a discharge is determined using the multiple-time-scale method. The equation is solved numerically for both heterogeneous and homogeneous conditions. A systematic bibliography of the cross-section data is presented, and a cross-section set is proposed for inelastic collisions. The numerical results obtained indicate the effect of the cross sections on the form of the distribution function. (auth) (France)

XUM

49895 (FRNC-TH-39) ELECTRON MULTIPLICATION IN A GAS SUBJECTED TO A CONSTANT ELECTRIC FIELD. Chatellard, Pierre (Toulouse Univ. (France)). 1971. 91p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Fluctuations in the electron avalanche amplification in a medium-pressure gas were studied. The electric field was uniform, and the primary ionization was produced by a single initial electron. The experimental results obtained with methane, in particular the affinities established between the spectra, led to a system of classifying the histograms according to E/p. For a given value of this parameter, all the histograms can be deduced from a single spectrum, dependent only upon E/p. The interpretation of this property using the process of Bellman and Harris enabled the phenomenon of multiplication by ionizing collisions to be studied from a microscopic point of view. (auth) (France)

49896 (NP-18961) MEASUREMENT AND INTERPRETATION OF ELECTRON DRIFT VELOCITIES IN HELIUM, NEON, ARGON, AND HYDROGEN. Robertson, A. G. (Australian National Univ., Canberra). Oct 1970. 254p. Dep. NTIS (U. S. Sales Only).

Thesis.

Low energy collision cross sections in the gases He, Ne, Ar were determined from measurements of transport coefficients of electron drift velocities. The drift velocities were extremely sensitive to the presence of impurities, the major source of error being the residual uncertainty in the level of N_2 impurity. The overall accuracy of the drift velocities was better than 1% (He), 2% (Ne) and 3% (Ar). In addition to the accuracy of the experimental data and the reliability of the analysis of the data, the accuracy of the cross sections was determined by the sensitivity of the calculated drift velocities to the momentum transfer cross sections giving accuracies better than 2% (He), 5% (Ne) and 7% (Ar). On the basis of Fromhold's hypothesis that the linear decrease in drift velocity with density observed in several gases is due to the formation of temporary negative ions by resonance capture of electrons, predictions were made for normal and parahydrogen, deuterium and helium. Extensive measurements indicated that the hypothesis qualitatively predicted the observed behavior of drift velocity as a function of the molecular number density and the ratio of the electric field strength to molecular number density. Assuming that the cross section for resonance capture is a δ-function, the behavior observed in normal and para-hydrogen is explicable in terms of resonances, associated with the $J = 0 \rightarrow 2$ and $J = 1 \rightarrow 3$ rotational transitions. (Australia)

49897 (SC-T-713054) THERMODYNAMIC EQUILIBRIUM IN SPARK PLASMAS. Krempl, H. Translated for Sandia Labs., Albuquerque, N. Mex., from Z. Phys.; 167: 302-25(1962). 35p. Dep. NTIS.

A simple method was established to calculate the composition and the line emission of a thermal plasma. The influence of a second component, e.g., the vapor of electrodes in a spark discharge, can thus be accounted for. Thermal equilibrium was demonstrated experimentally from the cooling curve of a brief high-current capacitor discharge. To achieve this, a new spectroscopic method of high-temperature measurement was developed. This works even where the oscillator strength is unknown. Moreover, the temperature value measured represents that of the plasma core. Temperature measurement involving different lines of different elements, i.e., of different atomic masses, will furnish similar results. This provides evidence for the existence of thermal equilibrium in spark discharges. (auth)

49898 (SC-T-713056) DETERMINATION OF NORMAL TEMPERATURES FOR NONTHERMAL PLASMAS. Kelm, Siegfried. Translated for Sandia Labs., Albuquerque, N. Mex., from Z. Phys.; 199: 261-74(1967). 19p. Dep. NTIS.

The normal temperatures are calculated for an optically thin plasma that is not in local thermodynamic equilibrium (LTE). The following cases are investigated: (1) normal temperatures for spectral lines of neutral atoms, and (2) normal temperatures for ion lines. Further, a distinction was made between lines whose upper energy levels were higher or lower than the "thermal limit". Formulas for the normal temperatures were derived for all important cases. The method of determining electron temperatures by finding the normal temperature can now be used also for plasmas not in LTE. (auth)

49899 INTERACTION OF TEST PARTICLES WITH A PLASMA. Laing, E. W.; Lamont, A.; Fielding, P. J. (Univ. of Glasgow). J. Plasma Phys.; 5: 441-54(Jun 1971).

The effect of a test particle, moving through a two-dimensional Maxwellian plasma, was studied both analytically and by computer simulation. For a stationary test particle, Debye shielding occurs. When the velocity of the test particle approaches the electron thermal velocity, there is a concentration of electrons several Debye lengths downstream, an effect which is essentially a heavily damped plasma oscillation. The analytic results agree closely with the computer simulation. As the velocity of the test particle increases, it is shown analytically that the damping diminishes, and eventually a fully developed plasma oscillation is established in the wake of the particle. (auth) (UK)

49900 EFFECTS OF ELECTRON–ELECTRON COULOMB INTERACTIONS IN LOW-VOLTAGE NEON DISCHARGE. Shaw, David T. (State Univ. of New York, Buffalo). J. Plasma Phys.; 5: 475-81(Jun 1971).

The electron-energy distribution in a neon discharge is determined from the Boltzmann equation. Inelastic collisions with neutral atoms, as well as electron–electron Coulomb interactions, are included in the calculation. It is shown that the distribution is very close to the Druyvesteyn function when the electron density is very low ($n_e < 10^7$ cm^{-3}). The same conclusion, however, is not correct as the electron density increases to a higher value ($n_e > 10^{11}$ cm^{-3}). In this case, the electron–electron Coulomb interactions play an important rôle in restoring the distribution toward a Maxwellian function. (auth) (UK)

49901 SOURCES OF PLASMA PHYSICS. VOLUME 1. Green, H. S.; Leipnik, R. B. Groningen, Netherlands; Wolters-Noordhoff Publishing (1970). 642p.

The following chapters are included: (1) fundamentals of magnetohydrodynamics and plasmadynamics, (2) introduction to electromagnetic fields, (3) fluid mechanics, (4) advanced electromagnetism, and (5) molecular theory of fluids. (M.O.W.)

49902 THERMODYNAMICS OF DENSE PLASMA. Norman, G. E.; Starostin, A. N. Zh. Prikl. Spektrosk.; 13: No. 1, 149-51(Jul 1970). (In Russian).

The present states of thermodynamics and statistical physics of dense (strongly ideal) plasmas are examined—plasmas in which the interaction energy of charged particles exceeds their kinetic energy. (tr-auth)

49903 PROPAGATION OF A PLASMA SHOCK WAVE ALONG A WEAK MAGNETIC FIELD. Pokhotelov, O. A. (Novosibirsk State Univ., USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 3, 372-5(Sep 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 3, 480-4(Mar 1971).

The propagation of a shock wave along a weak magnetic field in a plasma with $\beta = 4\pi p/H_0^2 \cong 1$ (p is the pressure of the plasma and H_0 is the magnetic field strength) is studied. This problem was considered earlier in two limiting cases: when $T_e/T_i \gg 1$ and $T_e/T_i \ll 1$. Here, no restrictions are imposed on the temperature ratio. The transition from one type of solution to the other is traced. (auth)

49904 AVERAGE FORCE ON A PLASMA IN A RADIO-FREQUENCY FIELD. Sever'yanov, V. V. (Tul'skaya State Pedagogical Inst., USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 3, 392-5(Sep 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 3, 504-9(Mar 1971).

The effect of a weak spatial inhomogeneity on the average force acting on a plasma in a radio-frequency field is studied. It is shown that such an inhomogeneity reduces the surface force. The body force is not changed. (auth)

49905 LOW-DENSITY PLASMA IN AN ELECTRIC FIELD. Gurevich, A. V.; Dnestrovskii, Yu. N.; Kostomarov, D. P.; Glukhikh, E. A. (Lomonosov State Univ., Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 3, 443-9(Sep 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 3, 572-80(Mar 1971).

The establishment of a steady state in a plasma in an external dc electric field which accelerates the ions is investigated using numerical techniques. The electron distribution is assumed to be stationary at any time. If the potential distribution is not monotonic, the electrons trapped in the potential well play an important role. If a small fraction of the electrons is trapped, the amplitude of the spatial potential oscillations is of the order of the potential differences across the plasma. (auth)

Production

49906 HIGH-FREQUENCY MODULATION OF AN ELECTRON BEAM AND PRODUCTION OF FAST IONS IN A COLD PLASMA. Koval'skii, N. G.; Khripunov, B. I.; Chuvatin, S. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 2, 232-6(Aug 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 2, 308-14(Feb 1971).

Hot ions are produced in a mirror machine by injection of a modulated beam of fast electrons. The measurements were performed over a wide range of parameters. The production of hot

ions by high-frequency beam modulation is most favorable at low plasma densities. Resonant heating at the ion-cyclotron frequency corresponding to the magnetic field at the center of the device is not observed. (auth)

49907 STIMULATED RAMAN SCATTERING IN INITIAL PHASE OF PLASMA PRODUCTION BY LASER. Mennicke, H. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Phys. Lett.; 36A: No. 2, 127-8(16 Aug 1971).

Stimulated Raman scattering was observed in the initial phase of plasma production by laser radiation from solid hydrogen and deuterium targets. Experimental results of spectroscopic and time resolved intensity measurements for different laser powers are reported. (auth)

49908 DYNAMIC VOLTAGE CURRENT CHARACTERISTICS OF A LINEAR PLASMA GENERATOR. Sergienko, A. S.; Shashkov, A. G. (Inst. of Heat and Mass Exchange, Minsk). Inzh.-Fiz. Zh.; 20: No. 4, 628-32(Apr 1971). (In Russian).

The voltage–current characteristics for the steady-state operation of a linear dc plasma generator with vortex stabilization are determined. For irregular change of current at low rates up to 50 A/sec, dynamic voltage–current characteristics are obtained which, as was found experimentally, show the existence of the electric arc hysteresis. The comparison of the characteristics shows that they are different under dynamic and static conditions. (auth)

49909 MICROWAVE DISCHARGE AT HARMONICS OF THE ELECTRON CYCLOTRON FREQUENCY. Budnikov, V. N.; Gorelik, V. P.; D'yachenko, V. V.; Novik, K. M.; Obukhov, A. A. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 3, 404-8(Sep 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 3, 520-5(Mar 1971).

Plasma generation by microwaves in a magnetic field was investigated. The plasma is produced in a quartz tube 70 cm long and 2.5 cm in diameter using 700 W of 3-cm power. The experiments are performed at argon pressures of 2×10^{-2} to 10^{-3} mm Hg. Plasma is observed along the whole tube at magnetic fields that are integral functions of the electron cyclotron field $H_c = \omega mc/e$. Measurements performed with double probes along the tube indicate the existence of fast electrons. These are due to the absorption of incident microwave energy in a small volume as a result of the marked increase in wave damping at harmonics of the electron cyclotron frequency. (auth)

Stability

49910 (AD-722085) LITERATURE SURVEY ON PLASMA INSTABILITIES, VOLUME I, REPORTS. Auer, Gerhard; Cap, Ferdinand; Floriani, Dietmar; Gratzl, Herbert (Innsbruck Univ. (Austria). Institut fuer Theoretische Physik). 31 Dec 1970. Contract F61052-70-C-0014. 181p. (UNICP-SR-75; AFOSR-TR-71-608). NTIS.

The report is the first volume of a literature survey on the largely extended field of plasma instabilities. Among other references the 1968–1970 issues of almost 40 relevant journals were looked through systematically. The first volume contains 121 more or less comprehensive single reports surveying all plasma instabilities which came to the authors' knowledge. Experimental observations as well as theoretical models of the instabilities are presented. A subject index (list of instabilities) enables the reader to find the survey report on a special instability. The abstracts of the references cited in this first volume will be presented in a second volume. (auth) (USGRDR)

49911 (IPP-1/115) INVESTIGATION OF THE M = 1 INSTABILITY OF A BUMPY THETA PINCH. Fuenfer, E.; Junker, J.; Kaufmann, M.; Neuhauser, J. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Dec 1970. 30p. (In German). Dep. NTIS (U. S. Sales Only).

The m = 1 instability of a bumpy theta pinch was studied using a coil 1.50-m long. The Isar I 2.6-MJ bank provides a collision-dominated plasma with $T_e = T_i$ = several hundred eV and a collisionless plasma with $T_e \ll T_i = 3.5$ keV. The particle density is 0.6 to 4.5 = 10^{16} cm^{-3}. The m = 1 instability generated by a sinusoidal expansion of the coil cross section can be sensitively influenced by relatively small field corrections. The observed m = 1 motion of the plasma cannot be explained by the theory of this instability unless the stabilizing effect of the ends of the coil is considered. The theoretical growth times are comparable with the time needed for an m = 1 wave to travel from the middle to the ends of the coil. The stability was not found to be affected by the absence of collisions. (auth)

49912 STABILIZATION OF THE TWO-STREAM INSTABILITY IN AN INHOMOGENEOUS PLASMA. Nemchinskii, V. A. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 2, 332-3(Aug 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 2, 435-8(Feb 1971).

The two-stream instability is considered in a slightly inhomogeneous plasma. As the wave propagates along the density gradient in the direction of higher densities, the phase velocity and growth rate vary continuously; the initial gain is converted to damping. Stabilization possibilities are discussed. (M.O.W.)

49913 INSTABILITY OF A PLASMA WITH TWO ION SPECIES IN A MAGNETIC FIELD WITH AN APPLIED ac ELECTRIC FIELD. Gurevich, L. E.; Vagner, I. D.; Ioffe, I. V. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 2, 334-5(Aug 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 2, 438-40(Feb 1971).

The intensity of a plasma with two ion species in combined electric and magnetic fields is considered. It is shown that the magnetic field has no effect on modes for which the azimuthal node number is equal to zero. Conditions under which the magnetic field becomes important are determined. Parametric excitation is also discussed. (auth)

49914 EFFECT OF STOCHASTIC rf FIELDS ON STABILITY OF PLASMA. Krlin, L. (Inst. of Plasma Physics, Prague). J. Plasma Phys.; 5: 331-42(Jun 1971).

The effect of stochastic high-frequency fields on the stability of electrostatic plasma oscillations in a magnetostatic field is studied. The stabilizing effect can be provided by diffusion in configuration co-ordinates, as well as in the longitudinal and transverse velocities. The parameters of the stochastic field for effective stabilization are estimated, as well as the influence of the accompanying escape of particles due to the stochastic fields. (auth) (UK)

49915 GRAVITATIONAL INSTABILITY OF A ROTATING MAGNETOPLASMA IN THE GUIDING-CENTRE APPROXIMATION. Lunn, A. D. (Mathematical Inst., Oxford). J. Plasma Phys.; 5: 365-73(Jun 1971).

Jeans's criterion for instability is found to be changed only for the case of perturbations perpendicular to the magnetic field and rotation parallel to it, when rotation and finite Larmor radius effects tend to stabilize the plasma. (auth) (UK)

49916 MAGNETIC STABILIZATION OF TRANSVERSE PLASMA INSTABILITIES. Buti, B.; Lakhina, G. S. (Indian Inst. of Tech., New Delhi). J. Plasma Phys.; 5: 467-74(Jun 1971).

Waves propagating transverse to the direction of the streaming of a plasma in the presence of a uniform external magnetic field are unstable if the streaming exceeds a certain minimum value. The magnetic field reduces the growth rate of this instability and also increases the value of the minimum streaming velocity, above which the system is unstable. The thermal motions in the plasma, however, tend to stabilize the system if the magnetic field is weak. (auth) (UK)

49917 LINEAR STABILITY OF EXPONENTIAL DENSITY PROFILES. Croci, R.; Saison, R. (Institut fuer Plasmaphysik, Garching, Ger.). J. Plasma Phys.; 5: 375-83(Jun 1971).

The problem of the linear stability of a plasma with density profiles $n(x) = A\exp(-ax)$ in a homogeneous magnetic field $B = \hat{i}_z B_0$ was solved exactly. The dispersion relation leads to stability criteria less severe than those obtained in the local approximation. Bernstein waves and the low-frequency drift instability are considered as examples. In the second example the marginal stability curve $k_z(n'/n)^{-1} = f(k_y R_i)$ is given for different values of the parameters $k_x R_i$, $R_i n'/n$, with $T_i = T_e$. Further, the same method is applied to a plasma with equilibrium distribution function $f_0 \sim \exp - (v_x^2 + e\phi)$ in a linear electric potential $\phi = ax$ and a homogeneous magnetic field $B = \hat{i}_x B_0$. (auth) (UK)

49918 INSTABILITIES IN A COLLISIONAL FINITE-PRESSURE PLASMA WITH TEMPERATURE INHOMOGENEITIES. Mikhailovskaya, L. V. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 2, 183-7(Aug 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 2, 241-7(Feb 1971).

Magnetohydrodynamic equations are used and allowance is made for the thermal fluxes as well as magnetic viscosity. The instability region is determined in the plane of the variables $\beta \equiv 16\pi n_0 T_0/B_0^2$ and $\eta \equiv \partial \ln T_0/\partial \ln n_0$. This region is multiply connected, indicating that there are several losses of instabilities. (auth)

49919 ORDINARY-MODE ELECTROMAGNETIC CYCLOTRON INSTABILITY IN PLASMAS. Lee, K. F. (Catholic Univ.

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of America, Washington, D. C.). Phys. Lett.; 36A: No. 3, 219-20(30 Aug 1971).

It is shown that in plasmas with loss-cone distributions, the ordinary mode can be unstable around harmonics of the cyclotron frequencies. (auth)

49920 THRESHOLDS OF TWO-STREAM INSTABILITY OF CURRENT IN A STRAIGHT DISCHARGE. Karchevskii, A. I.; Strakhov, Yu. I. JETP Lett. (USSR) (Engl. Transl.); 13: No. 11, 424-7(5 Jun 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 13: No. 11, 595-9(5 Jun 1971).

The ASPA setup was used to investigate the excitation of anomalous resistance (R) upon termination of the discharge and the dependence of R on the initial plasma density n_{e0} and on the discharge voltage U_0 on the capacitor. Diagrams showing plasma resistance vs discharge voltage are given. (M.O.W.)

Thermonuclear Processes

Refer also to abstract 50597.

49921 (LA-4664) PERHAPSATRON S-5 AND S-5 ZEUS EXPERIMENTS REVIEWED IN LIGHT OF CURRENT TECHNOLOGY. Phillips, J. A. (Los Alamos Scientific Lab., N. Mex.). Mar 1971. Contract W-7405-eng-36. 14p. Dep. NTIS.

The toroidal z-pinch experiments PS-4 and PS-5 Zeus, run at Los Alamos between 1958 and 1961 are described. These two experiments were the last in a series of Perhapsatrons in which stabilization of the pinch was attempted by the inclusion of a longitudinal B_z magnetic field and a close conducting wall. The data are discussed in terms of present understanding of the stable diffuse pinch. (auth)

49922 (MATT-Q-28, pp 64-74) ENGINEERING AND DEVELOPMENT. (Princeton Univ., N. J. Plasma Physics Lab.).

In Annual report, January 1-December 31, 1970.

Major projects for this year were conversion of the spherator to a levitated superconducting-ring device, conversion of the Model C stellarator to a symmetric Tokamak, and the continued fabrication of the FM-1 floating multipole device. Summaries are given for these projects along with work on digital control and data acquisition systems. (M.O.W.)

49923 (NP-18943) MULTITUBE GENERATING BANK. Zverev, G. I.; Lyul'ev, V. L.; Mayburov, V. B.; Savchenko, I. S.; Yampol'skii, I. R. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Sukhumi. Fiziko-Tekhnicheskii Institut). 1970. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

Four-phase vacuum-tube oscillators for exciting circuits forming high-frequency fields of various configurations for plasma physics research are described. The oscillators can operate in two modes: independent excitation and self-exciting oscillation. In the self-exciting oscillation mode, the field-forming circuit is the load. The total installed power of the generating bank tubes is more than 80 MW in a 1 to 1.5-msec pulse with a duty cycle of 0.5 to 2 mHz and a pulse repetition rate of 0.05 to 0.1 Hz. The problem of obtaining high power is solved by summing the powers of the groups of oscillator tubes included in parallel in the load. (JPRS)

49924 (UCRL-51051) NUMERICAL SIMULATION OF RELATIVISTIC ELECTRONS CONFINED IN AN AXISYMMETRIC MIRROR FIELD. Brettschneider, Marcel (California Univ., Livermore. Lawrence Radiation Lab.). 11 May 1971. Contract W-7405-eng-48. 145p. Dep. NTIS.

Thesis.

In the controlled fusion experiment Astron, a beam of relativistic electrons is injected into a partially evacuated cylindrical region in which an externally applied magnetic field has been established. A mathematical model capable of simulating the formation of the E-layer is described. The model assumes axial symmetry. It includes the effects of the neutralization of the electric field of the injected electrons due to their interaction with the background gas. The E-layer contains about 10^{15} electrons. The electrons are approximated by about 3×10^4 superparticles. A superparticle is equivalent (in charge and mass) to about 3×10^{10} electrons. Each superparticle is followed individually. Its trajectory is determined from the solution of the relativistic equations of motion. A superparticle interacts only with the electromagnetic field. It is unaware (except through their influence on the field) of the existence of other superparticles. The superparticles move freely through each other. Thus, in this sense, the model is collisionless. The equations of motion are solved by using a time-centered, leap-frog difference scheme. Two different difference approximations are used in solving the wave equations. One is an alternating direction implicit scheme. The other is an explicit scheme. The two methods are compared. This model was used to study the formation of an E-layer when one pulse of electrons was injected. It was also used to study the effect of injecting a number of pulses in succession. The results are in good qualitative agreement with the observed experimental results. (auth)

49925 (UCRL-71010(Pt.2)) LARGE SUPERCONDUCTING BASEBALL MAGNET. PART II. Henning, C. D.; Nelson, R. L.; Calderon, M. O.; Chargin, A. K.; Harvey, A. R.; Denhoy, B. S. (California Univ., Livermore. Lawrence Radiation Lab.). 18 Feb 1971. 19p. (CONF-710811-2). Dep. NTIS.

From thirteenth international congress of refrigeration; Washington, D. C. (27 Aug 1971).

A superconducting magnet was constructed for a plasma confinement experiment in controlled thermonuclear fusion. Shaped like the seam of a baseball, the magnet is about 6 ft in diameter and can produce a cusped magnetic field of close to 20 kG in the center and 75 kG at the winding. The conductor is a $\frac{1}{4}$-in.-square composite of niobium-titanium strands coextruded in a copper matrix. Forty-thousand feet of this conductor was wound onto a high-manganese stainless steel housing, which restrains the magnetic forces and separates the liquid helium around the conductor from the surrounding ultrahigh-vacuum environment. Sophisticated cryogenic and electrical systems greatly facilitate the daily use of the magnet for fusion research. (auth)

49926 SPATIAL MAGNETIC CONFIGURATIONS WITH SHEAR AND MINIMUM B WITHOUT AN EXTERNAL LONGITUDINAL FIELD. Loktionov, Yu. M.; Sebko, V. P. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 2, 329-31(Aug 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 2, 433-5(Feb 1971).

It is shown that closed magnetic surfaces having shear and minimum B can be produced in spatial magnetic configurations of the Torsatron type when there is an axial current, even without an external longitudinal magnetic field. These configurations have several advantages as compared with the standard Torsatron systems. (auth)

49927 METHOD FOR THE EXPERIMENTAL DETERMINATION OF THE DEPTH OF MAGNETIC WELL IN A SYSTEM WITH MINIMUM B. Glagolev, V. M.; Skosyrev, Yu. V.; Shmarin, A. A. At. Energ. (USSR); 30: No. 4, 401-2(Apr 1971). (In Russian).

The presence of minimum B is one of the fundamental requirements of magnetic systems designed for the stable thermal isolation of plasma. The methods used to determine the minimum B involved the superposing of special transverse fields on the longitudinal ones. Such a method of determination was developed within a system involving components of the homogeneous field on the basis of earlier studies of one of the authors. The magnetic well in the trap was created by the elongation of the central lines of force, when applying transverse harmonically changing fields to the homogeneous longitudinal field. The stabilizing core system was displayed at the surface of a cylindrical 150-mm diameter vacuum chamber. The results of the measurement of minimum B agreed with transverse field values for which the largest magnetic input surface had a diameter of 40 mm. The relative error in the surface measurements amounted to 0.5%. (TTT)

49928 TOKAMAK WITH SUPERPOSED MULTIPOLE MAGNETIC FIELD. Feneberg, W. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Phys. Lett.; 36A: No. 2, 125-6(16 Aug 1971).

It is proposed that multipole magnetic fields be superposed on the Tokamak to produce an equilibrium such that the plasma is separated from the wall by a magnetic separatrix. The equilibrium is calculated for a special configuration with four conductors in which small deviations from circular symmetry are assumed. (auth)

49929 MAGNETIC SURFACES IN STRAIGHT VINTOTRON AND VINTOTORUS CONFIGURATIONS. Loktionov, Yu. M.; Sebko, V. P.; Tyupa, V. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 2, 326-8(Aug 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 2, 430-3(Feb 1971).

Point electron beams were used in an experimental study with a straight model of the magnetic field structure of the spatially periodic configurations of the Vintotron (n = 1) and the Vintotorus (l = 2). The results are found to correspond to calculated data, within the range of applicability of the theory. (auth)

49930 DEMONSTRATION OF A BODY FORCE PRODUCED ON A θ-PINCH PLASMA COLUMN BY HELICAL MAGNETIC FIELDS. Harder, C. R.; Ribe, F. L.; Siemon, R. E.; Thomas,

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K. S. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett.; 27: No. 7, 386-9(16 Aug 1971).

Experiments are described in which small helical magnetic fields are added to the basic confinement field of a 3-m-long θ pinch. A combination of these fields having $l = 1$ and $l = 0$ symmetries produces a transverse body force on the plasma column. The strength of the body force was measured by studying the plasma dynamics and was found to be in agreement with the theoretical value. (auth)

Wave Phenomena

Refer also to abstracts 49639 and 49802.

49931 (NP-18982) EXCITATION OF ELECTROMAGNETIC WAVES IN A PLASMA BY A RELATIVISTIC ELECTRON BEAM. I. LONGITUDINAL WAVES. Rukhadze, A. A.; Bogdankevich, L. S.; Dolzhenno, O. V. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). May 1971. 25p. (In Russian). Dep. NTIS (U. S. Sales Only).

A metal waveguide of radius R is filled with a plasma through which a relativistic electron beam with radius $r < R$ passes. The hydrodynamic equations are given for a collision-free, cold plasma contained by a external longitudinal magnetic field B which is greater than the beam current field. On linearizing this set of equations for small deviations from a stationary equilibrium state, a partial differential equation is obtained for the perturbed field potential. The conditions for beam instability and cyclotron instability are explored over a rather narrow range of high-frequency plasma oscillations for the case of $r = R$. The conditions for long- and short-wave oscillations are also given at $r < R$. A discussion is presented on the production of radiation in the region of wavelengths $l = 10^{-1}$ to 3 cm on interaction of a 1-MeV electron beam with a plasma having a particle density of 10^{10} to 10^{12} particles/cm^3. (TTT)

49932 (ORNL-tr-2495) DEVELOPMENT OF UNSTABLE CYCLOTRON OSCILLATIONS IN AN INHOMOGENEOUS MAGNETIC FIELD. Timofeev, A. V. (Institut Atomnoi Energii, Moscow (USSR)). Translated for Oak Ridge National Lab., Tenn., from report IAE-2089. 29p. Dep. NTIS.

The evolution of short-wave quasi-classical oscillations in inhomogeneous media is considered, using the Laplace transform method. The perturbations, arbitrarily depending on the coordinates, take the form of a superposition of elementary perturbations, which initially had the form of a δ-function. An equation is derived establishing the frequency of the elementary perturbation as a function of the coordinates and of time. It is demonstrated that the concept of a wave packet in inhomogeneous media is of limited validity, since with a sufficiently sharp change in the oscillation increment in space, the interference of elementary perturbations forming the packet may lead to mutual cancellation. This is discussed with the example of unstable cyclotron oscillations in an inhomogeneous magnetic field. In a monotonically increasing field the perturbations increase for a finite time, after which their amplitude no longer varies. The magnification factor does not depend on the form of the perturbation. If the magnetic field varies non-monotonically, the perturbations increase during the entire period of time which can be measured with these methods. (auth)

49933 GROWTH RATES OF PLASMA OSCILLATIONS FOR SYMMETRICAL DOUBLE-HUMPED VELOCITY DISTRIBUTIONS. Nishimura, Keiichi (Univ. of California, Livermore). J. Plasma Phys.; 5: 455-8(Jun 1971).

Inside any symmetrical double-humped plasma velocity distribution, all growing waves with real wave-number have zero phase velocity. Growth rates of such plasma oscillations are calculated for distributions made up of resonance functions and of Gaussian functions. The results are compared with an earlier calculation made with less realistic distribution functions with no infinite tails. (auth) (UK)

49934 COHERENT ION PLASMA OSCILLATIONS IN A dc CORONA DISCHARGE IN RAREFIED AIR. Lilienfeld, Pedro (GCA Corp., Bedford, Mass.). J. Plasma Phys.; 5: 459-65 (Jun 1971).

Stable, phase-coherent ion plasma oscillations are found superimposed on the dc potential and current of positive coaxial corona discharges in air at pressures of the order of $1/100$ of one atmosphere. The frequency of these oscillations, typically several hundred kHz, is a function of air density, and varies with the concentration of gaseous trace contaminants. (auth) (UK)

49935 ELECTRON CYCLOTRON ECHOES FROM PLASMA. Bruce, R. L. (Stanford Univ., Calif.). J. Plasma Phys.; 5: 385-411(Jun 1971).

The observed response of a low-density magnetoplasma column to a pair of rf pulses near the cyclotron frequency is a series of pulses known as two-pulse echoes. A similar three-pulse echo train may be obtained by applying a third pulse. This behaviour involves some type of nonlinearity, and for a low-density plasma the most promising mechanism appears to be velocity-dependent electron-neutral collisions. This gives velocity-dependent decay to induced currents and velocity-dependent diffusion. The latter may be important in three-pulse echo formation. Computations from these theories are compared with experimental data with these findings: diffusion is not primarily responsible for three-pulse echoes; the predictions of the collisional current decay theory are in reasonable agreement with the experimental results. (auth) (UK)

49936 NONLINEAR INTERACTION BETWEEN THREE ORDINARY ELECTROMAGNETIC WAVES. Stenflo, L. (Inst. of Physics, Uppsala). J. Plasma Phys.; 5: 413-25(Jun 1971).

The nonlinear interaction between three resonant, modified ordinary electromagnetic waves, which propagate perpendicular to a constant magnetic field in a spatially homogeneous electron plasma, is considered. The coupling coefficients are calculated and discussed. Finally, a general formula, describing the interaction between three waves propagating at arbitrary angles to the static field, is derived. (auth) (UK)

49937 EFFECT OF ION MOTION ON PARAMETRIC OSCILLATIONS OF A COLD PLASMA IN A MAGNETIC FIELD. Prasad, R. (Hooghly Mohsin Coll., Chuchura, India). J. Plasma Phys.; 5: 291-302(Jun 1971).

Dispersion relations for first-order oscillations in an infinite homogeneous two-component plasma in response to an externally applied constant magnetic field and a right-hand circularly polarized external electric field, and with propagation vector parallel to the magnetic field, were obtained. The external electric field, assumed to be spatially homogeneous, is perpendicular to the applied magnetic field. It has been shown that the left-hand mode is excited and is unstable when its frequency $\simeq \nu - \omega_p$, where ν is the frequency of the external electric field and ω_p is the characteristic plasma frequency. When the applied magnetic field is large, both the left- and right-hand modes are excited and may be unstable when their frequencies $\simeq \Omega_{ic} - \omega_p$, where Ω_{ic} represent the electron ($i = 1$) and the ion ($i = 2$) cyclotron frequencies. The principal criterion for the validity of these results is the condition of spatial homogeneity of the external electric field. (auth) (UK)

49938 GEOMETRIC OPTICS IN AN IDEAL MAGNETOHYDRODYNAMIC FLUID. Bernstein, Ira B. (Yale Univ., New Haven). J. Plasma Phys.; 5: 303-13(Jun 1971).

The propagation of small monochromatic disturbances in a stable ideal magnetohydrodynamic fluid is treated by the method of geometric optics. The medium is tri-refringent and requires six systems of rays. The problem of a point radiator is solved in the small wavelength limit where the theory holds. (auth) (UK)

49939 RELATIVISTIC KINETIC THEORY OF THE LARGE-AMPLITUDE TRANSVERSE ALFVEN WAVE. Barnes, Aaron; Suffolk, Graham C. J. (Ames Research Center, Moffett Field, Calif.). J. Plasma Phys.; 5: 315-29(Jun 1971).

It is shown that the relativistic Vlasov-Maxwell equations admit a solution very much like the transverse Alfvén wave of magnetohydrodynamic theory. This wave propagates as a plane electromagnetic wave of arbitrary amplitude, is noncompressive, is associated with fluctuations in direction (but not magnitude) of magnetic field, is characterized by a nonlinear "dispersion relation", and reduces in the limit of small amplitude to the transverse Alfvén mode of linearized plasma wave theory. The dispersion relation yields a criterion for the firehose instability which turns out to be the same as that derived from linearized theory. (auth) (UK)

49940 EFFECTS OF ION-ION COLLISION ON AN ION-ACOUSTIC PLASMA PULSE. Espedal, Magne S. (Univ., Bergen). J. Plasma Phys.; 5: 343-55(Jun 1971).

The effects of ion-ion collisions, described by a Fokker-Planck operator in the kinetic equation, on an ion-acoustic plasma pulse, are studied. It is found that the collisions give a broadening of the pulse and reduce the effect of interaction between the main plasma and the pulse. (auth) (UK)

49941 STABILITY OF PARAMETRICALLY EXCITED DRIFT WAVES. Siambis, John G. (Carnegie-Mellon Univ., Pittsburgh). J. Plasma Phys.; 5: 357-63(Jun 1971).

The propagation and stability of drift waves are examined by means of a perturbation technique in geometries where the mag-

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nitude of the magnetic field varies periodically along the field lines. Two sets of modes are found that can be driven unstable by resonant particles trapped in the magnetic field nonuniformity. One set of modes consists of standing waves with wavelength twice that of the magnetic field nonuniformity. The other set of modes consists of standing waves composed essentially of the sum of a component that does not vary along the line and a component that is a standing wave with wavelength equal to the wavelength of the magnetic field nonuniformity. The advantage of this method is that it predicts simply and pictorially the real frequency of oscillation for these modes. (auth) (UK)

49942 LONGITUDINAL WAVES IN A HOMOGENEOUS PLASMA SHEATH. Zhvaniya, I. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 2, 188-90(Aug 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 2, 248-51(Feb 1971).

A kinetic theory is constructed for longitudinal waves in a homogeneous plasma sheath with mirror boundary conditions. A dispersion relationship is found for an arbitrary distribution function of the unperturbed system. The effect of the boundary conditions on the dispersion characteristics is considered. (auth)

49943 PARAMETRIC WAVE EXCITATION IN A WEAKLY IONIZED PLASMA. Markeev, B. M. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 2, 195-9(Aug 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 2, 259-65(Feb 1971).

Parametric excitation of electromagnetic oscillations in a weakly ionized plasma, located in a weak, uniform hf field, is investigated in the hydrodynamic region of frequencies and wavelengths (ω, $kv_{Te} \ll \nu_{en}$). The threshold hf fields at which instabilities can arise in the system, as well as the frequencies and growth rates, are determined. It is shown that electrostatic instabilities can develop in the system at external field frequencies above the electron collision frequency. At the other extreme, when the external field frequency is lower than the frequency of electron collisions with neutrals, only electrostatic transverse oscillations can be unstable. (auth)

49944 CHERENKOV ION ACOUSTIC WAVE RADIATION GENERATED BY A PSEUDOWAVE. Estabrook, K.; Alexeff, I. (Oak Ridge National Lab., Tenn.). Phys. Lett.; 36A: No. 2, 95-6(16 Aug 1971).

Ion acoustic waves in a plasma are observed to propagate in a cone of Cherenkov radiation outward from the path of a pseudowave packet (ion burst) that generates them. (auth)

49945 AMPLIFICATION EFFECT DUE TO LARGE-AMPLITUDE ELECTRON PLASMA WAVES. Kawai, Y.; Kondo, K. (Nagoya Univ., Japan). Phys. Lett.; 36A: No. 2, 137-8(16 Aug 1971).

Upon increasing the amplitude of plasma waves excited externally by grids, electron plasma oscillations excited spontaneously become amplified. (auth)

49946 ABSORPTION OF ELECTROSTATIC WAVE IN BOUNDED PLASMAS. Ohkubo, K.; Yamamoto, Y.; Tanaka, S. (Kyoto Univ.). Phys. Lett.; 36A: No. 2, 143-4(16 Aug 1971).

By exciting the Trivelpiece mode with a high-power rf signal, production and heating of plasma electrons are observed; these are ascertained by change of the dispersion, the signal intensity, and Langmuir-probe characteristics. (auth)

49947 PROPAGATION OF ELECTRON WAVES IN A PLASMA AT LOWER FREQUENCY THAN PLASMA FREQUENCY. Kawai, Y.; Kondo, K.; Saka, O.; Kawabe, T. (Nagoya Univ., Japan). Phys. Lett.; 36A: No. 2, 149-50(16 Aug 1971).

It is found that an electron pseudo wave is excited and that it propagates on a different dispersion relation from the ordinary one for the electron plasma wave. These results are compared with theoretical calculations of the electron pseudo waves. (auth)

49948 SPATIALLY DECAYING LOW-FREQUENCY WAVES IN A CESIUM PLASMA WITHOUT MAGNETIC FIELD. Cussenot, J. R.; Fabry, M. (Laboratoire de Physique des Milieux Ionises, Nancy). Phys. Lett.; 36A: No. 3, 235-6(30 Aug 1971).

In a cesium plasma, without magnetic field, the spatial propagation of low-frequency disturbances is investigated. Results are interpreted according to a Fresnel interference pattern, taking into account collision processes. (auth)

49949 NONLINEAR EFFECTS ON A PARAMETRIC EXCITATION OF ION PLASMA WAVES. Amagishi, Y.; Yamagiwa, K.; Kozima, H.; Kato, K. (Shizuoka Univ., Japan). Phys. Lett.; 36A: No. 3, 241-2(30 Aug 1971).

Asymmetrical and hysteresis behavior on a parametric excitation of ion plasma waves was observed in a mercury discharge plasma with no magnetic field. (auth)

49950 RESONANCE BROADENING IN MODE COUPLING. Kaufman, Allan N. (Princeton Univ., N. J.). Phys. Rev. Lett.; 27: No. 7, 376-8(16 Aug 1971).

The nonlinear interaction of N oscillators, with N not too small ($N \sim 10$), is treated statistically. A diffusion equation for the probability density in action space describes its evolution to a microcanonical distribution over the portion of the energy hyperplane for which the resonance widths (or relative-phase diffusivities) are nonvanishing. These widths are determined in terms of the resonance frequency mismatches and the nonlinear interaction coefficients by nonlinear coupled equations. For diffusion to occur, the interaction strengths must exceed the mismatches. (auth)

49951 BUILDUP OF NONELECTROSTATIC OSCILLATIONS BY A TRANSVERSE CURRENT. Parail, V. V. (Moscow Physical-Technical Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 3, 376-81(Sep 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 3, 485-92(Mar 1971).

Nonelectrostatic helicon and magneto-acoustic instabilities caused by the passage of a current transverse to the field H_0 in a plasma are treated in the linear approximation. It is shown that the intrinsic magnetic field of the current must be treated; in the hydrodynamic approximation this requirement leads to the stability of pure transverse oscillations with $k_z = 0$. The instability arises in a hot plasma because of the thermal spread of the ion velocities even with $T_i < T_e$; in the quasi-linear approximation this process leads to effective ion heating. (auth)

49952 AMPLIFICATION OF SOUND WAVES IN A WEAKLY IONIZED PLASMA. Tskhakaya, D. D. (Inst. of Physics, Tbilisi, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 3, 386-7(Sep 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 3, 497-9(Mar 1971).

It is shown that a weakly ionized plasma in an external alternating electric field generates sound waves at a frequency equal to that of the external field. The growth rate is obtained. (auth)

49953 REFLECTION OF ELECTROMAGNETIC WAVES IN A MOVING PLASMA. Gavrilenko, V. G.; Lupanov, G. A.; Stepanov, N. S. (Gorky State Univ., USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 3, 415-18(Sep 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 3, 534-8(Mar 1971).

The reflection of electromagnetic waves from the interface between stationary and moving electron plasmas is discussed. Thermal motion is neglected, the boundary conditions at the velocity discontinuity are made more precise, and it is shown that reflection occurs even when the plasma densities are the same in the reference systems in which the plasmas are at rest. (auth)

49954 OBSERVATION OF SELF-FOCUSING OF ELECTROMAGNETIC WAVES IN A PLASMA. Eremin, B. G.; Litvak, A. G. (Inst. of Radio Physics, Gorky, USSR). JETP Lett. (USSR) (Engl. Transl.); 13: No. 11, 430-2(5 Jun 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 13: No. 11, 693-7(5 Jun 1971).

An evacuated cylindrical volume was filled with plasma with maximum concentration $n_e = 8 \times 10^{13}$ cm^{-3}. A microwave pulse was fed to the plasma. Oscillograms of pulses passing through the plasma are given. The self-focusing effects are discussed. (M.O.W.)

Shielding

Refer also to abstracts 48735, 48739, 48936, 49173, 49595, 50056, 50271, 50453, 50455, 50456, 50464, 50465, 50478, 50573, 50701, and 51060.

49955 (AD-715409) MONTE CARLO STUDY OF GAMMA-RAY ATTENUATION IN STRUCTURES WITH BASEMENTS. Final Report. Hinkley, D. E. (Radiation Research Associates, Inc., Fort Worth, Tex.). 8 Jul 1970. Contract DAHC20-70-C-0202. 12p. (RRA-T-703). NTIS.

A theoretical investigation of the radiation reaching the basement of cylindrical concrete structures surrounded by a ^{60}Co simulated fallout field was carried out using Monte Carlo techniques to determine the effects of wall height, wall thickness, floor thickness, and detector location. Also, reduction and attenuation factors obtained from Monte Carlo and other calculational methods were compared. The structures considered were 10 ft in radius, with wall heights between 4 ft and 10 ft and with a 40-psf roof. Wall thicknesses of 20, 40, and 80 psf and basement-ceiling thicknesses of 0, 20, and 40 psf

were considered. The wall thickness was found to have relatively little effect on the shape of the reduction factor or the magnitude of the floor attenuation factor as functions of detector location and floor thickness. Increasing the wall height resulted in an increase in both the reduction factor and the attenuation factor. The Monte Carlo results were compared with those of the original and various proposed improved versions of the engineering method. For the case analyzed, the extended engineering and Batter–Starbird results tended to overpredict the reduction factor, while the engineering method gave fairly good agreement for solid-angle fractions in the neighborhood of 0.7. The extended engineering and Eisenhauer attenuation factors agreed to within 15% of the Monte Carlo data for the 20-psf basement-ceiling case, and to approximately within 40% when the basement-ceiling thickness was increased to 40 psf. (auth) (USGRDR)

49956 (AD–721621) ANALYSIS OF IN-AND-DOWN SCATTERED RADIATION MEASUREMENTS IN A BASEMENT. Final Report. Jenkins, Alvin L.; Hinkley, David E.; Schmoke, Murray A. (General Physics Corp., Ellicott City, Md.). Jan 1971. Contract DAAA15-67-C-0589. 157p. (BRL–1522). NTIS.

The results of extensive measurements of in-and-down scattered radiation in the basement of a rectangular concrete structure are analyzed. These measurements were made in a fallout field simulated with a circulating ^{60}Co point source as a function of above-ground wall height and wall thickness and of the thickness of the overhead cover. The results are analyzed in terms of effective floor factors, effective wall factors and effective ceiling factors. These factors as calculated by the engineering method are compared with those calculated by other investigators. A different method of calculating the far-field correction was developed for experiments in which both skyshine and in-and-down scattered radiation are measured. (auth) (USGRDR)

49957 (AERE-M–2346) ENERGY LOSS CHARACTERISTICS OF HEAVY IONS IN NITROGEN, CARBON DIOXIDE, ARGON, HYDROCARBON GASES AND TRADESCANTIA TISSUE. Dennis, J. A. (Atomic Energy Research Establishment, Harwell (England)). Feb 1971. 44p. Dep. NTIS (U. S. Sales Only). UK 35p.

Tabulated values are given in the energy range 1 eV to 20 MeV of the nuclear and total stopping powers of the gases nitrogen, carbon dioxide, argon, methane, ethylene and acetylene for protons, alpha particles, and ions of argon, carbon, nitrogen, and oxygen. Values are also given for the factor f(E) which represents the fraction of the initial proportion of a decrement δE of energy loss by an ion of energy E in elastic nuclear scattering that is finally dissipated as this form of energy loss. The mean energy transferred to the medium as elastic nuclear scattering by an ion that is completely stopped in the medium is also given. Similar quantities are given for the tissue of Tradescantia occidentalis. The tables are of use for understanding the details of energy deposition in gases and biological materials irradiated either with neutrons or heavy particles, as well as for the calculation of W, the mean energy to form an ion pair in a gas. The data have been derived from a combination of experimental measurements reported in the literature and theoretical calculations. (auth)

49958 (LA–4734) TABLES OF EQUAL WEIGHT QUADRATURE EQ_n OVER THE UNIT SPHERE. Carlson, Bengt G. (Los Alamos Scientific Lab., N. Mex.). Jul 1971. Contract W-7405-eng-36. 15p. Dep. NTIS.

Tables of symmetric equal weight quadrature over the unit sphere, called EQ_n, are given for n = 2, 4, ..., 16, together with a number of associated tables, the related sets EP_n for one-dimensional quadrature, comparisons with other quadrature methods, and a brief description of the assumptions and procedures used to determine the EQ_n and EP_n sets. (auth)

49959 (UCRL–51045) CABLE SHIELDING FROM PHOTON SCATTERING FOR PINEX EXPERIMENTS. Buchla, D. M.; Harper, T. L.; Wobser, J. K. (California Univ., Livermore. Lawrence Radiation Lab.). 30 Apr 1971. Contract W-7405-eng-48. 35p. Dep. NTIS.

Gamma-induced noise in coaxial signal cables transmitting prompt data on events containing a pinex (PInhole Neutron EXperiment) has caused loss of prompt data on a number of events. Monte Carlo calculations of photo transport outside the pinex pipe with and without internal pipe collimators were made. These calculations were used to determine the induced cable noise current. Recommended shielding arrangements to reduce the induced noise current to an acceptable level are given. In addition, time dependent buildup in the cables is described. (auth)

49960 DEPTH DISTRIBUTION OF ABSORBED ENERGY AND DOSE FOR VARIOUS MATERIALS IN BREMSSTRAHLUNG IRRADIATION WITH MAXIMUM ENERGY UP TO 1000 MeV. Vorob'ev, A. A.; Vorob'ev, V. A.; Pushkin, A. V. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 1, 24-32(1971). (In Russian).

The transmission and absorption of high-energy bremsstrahlung was studied by means of a photographic technique, using a synchrotron as the source of the bremsstrahlung. The depth distribution of the absorbed energy (DDAE) and of the absorbed dose (DDAD) from 250 to 1000 MeV was measured in graphite, Al, Cu, Pb, Fe, and crystalline KCl, KBr, and KI. Equations were developed that describe the dependence of DDAD and DDAE upon the maximum energy of the bremsstrahlung, the atomic number of the absorber material, and the radiation conditions. (K.S.W.)

49961 SINGULARITY OF A CONJUGATE FUNCTION IN THE CASE OF A POINT DETECTOR OF GAMMA RADIATION. Kol'chuzhkin, A. M.; Uchaikin, V. V. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 1, 106-10 (1971). (In Russian).

The transport equation for gamma radiation was examined. The singularity of the conjugate function was defined for a point detector, and examples of its application to concretes are included. (tr-auth)

49962 STOPPING OF 1- TO 1.8-keV ^{73}Ge ATOMS IN GERMANIUM. Jones, K. W.; Kraner, H. W. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 4: No. 1, 125-9(Jul 1971).

Measurements of the amount of energy lost to ionization in the stopping of low-energy ^{73}Ge atoms, produced by inelastic neutron scattering in a germanium γ-ray detector, were extended down to energies of about 1 keV. The results are about 35% higher than theoretical values of the Lindhard theory found from an extrapolation to this energy region. The energy of the ^{73}Ge third excited state was measured for this experiment and found to be 68.752 ± 0.007 keV. (auth)

49963 DETERMINATION OF THE ENERGY LOSS OF RELATIVISTIC ELECTRONS IN THICK LEAD AND TUNGSTEN TARGETS. Anan'ev, V. D.; Matora, I. M. This paper was summarized in At. Energ. (USSR); 29: No. 4, 285-6(Oct 1970) as paper No. 433/5803. (In Russian).

An experiment performed at the microtron of the Laboratory of Neutron Physics to determine the energy loss of electrons in thick lead and tungsten targets is described. The results presented can be used in calculations of thick targets for high-current accelerators. (TSS)

49964 CALCULATION OF PHOTONEUTRON DISTRIBUTION BY MONTE CARLO METHOD. Morozov, A. A.; Khisamutdinov, A. I. This paper was summarized in At. Energ. (USSR); 29: No. 6, 449-50(Dec 1970) as paper No. 448/5637. (In Russian).

A pulsed source of γ rays placed at a height h above the surface of the earth emits 1.667 to 2.2-MeV photons in a cone of a given angle. The photons fall on beryllium-bearing rock and initiate photonuclear reactions in beryllium, producing neutrons which pass through the air. The beryllium is assumed to be uniformly spread through the rock. The quantities investigated are the integrated neutron fluxes in given time and energy intervals at various distances from the source. The neutron flux depends on the parameters of the beryllium-containing rock as well as on height, time, energy, and distance from the source. Plane symmetry in the neutron part of the problem and the uniformity of time were used in finding the required integrated fluxes by a specially developed modification of the Monte Carlo method. Local flux calculations were thus avoided. In the process of solving the problem the neutron trajectory was displaced to the proper point in phase space and then the corresponding "importance of production" was calculated at the point of actual production. Time histograms were obtained and interpreted for beryllium-bearing granite with porosities of 0, 3, and 6%, energy intervals of 0 to 0.4 and 0.4 to 400 eV, heights h of 20, 45, and 100 m, and distances from the source r of 0 and 10 m. The time axis of the histograms contains the time intervals 10^{-5} to 10^{-3}; 10^{-3} to 5×10^{-3}; 5×10^{-3} to 10^{-2}; 10^{-2} to 5×10^{-2}; and 5×10^{-2} to 10^{-1} sec. The results of the calculations confirm the possibility of air prospecting for beryllium from a height of 45 to 60 m with a γ source ~5×10^{12} photons/sec for a beryllium density of ~10^{-5} g/cm^3, and can contribute to the choice of optimum instrument characteristics. (TSS)

49965 CALCULATION OF THE TOTAL DOSE IN CONCRETES FOR RADIATION SHIELDING DESIGN. Havranek, M. (Univ., Stuttgart). Nucl. Eng. Des.; 16: No. 3, 249-52(Jul 1971).

Because of a possible strong influence of the secondary gamma radiation on the total dose it is necessary to perform coupled neutron and gamma-ray calculations. The secondary gamma rays produced by neutron interactions become sources in the gamma-ray groups through a group-to-group transfer matrix. Neutron

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and gamma-ray dose and fluxes as well as the total neutron and gamma-ray dose in two different serpentine concretes were calculated using a 40-group coupled set (22 neutron and 18 gamma-ray), which describes well the oxygen total cross section valley near 2.37 MeV. The results of discrete-ordinary calculations for 250-cm concrete slab thickness show that the secondary gamma-ray dose becomes very important for lower energies and larger slab thicknesses. (auth)

49966 REMEDIES FOR RAY EFFECTS. Lathrop, K. D. (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng.; 45: No. 3, 255-68(Sep 1971).

Remedies are considered for the ray effect, a flux distortion producing defect of the discrete-ordinates approximation to the transport equation. The partially effective remedies of increasing the number of directions, selecting quadrature sets invariant under discrete rotations, and introducing coupling terms into the representation of the transport divergence operator are considered. Numerical results are presented showing the effectiveness of these remedies in a standard test problem. Remedies that eliminate the ray effect are also considered. How to formulate multidimensional discrete ordinate equations equivalent to spherical harmonic equations is shown, and the order of the equivalent spherical harmonic equations is related to the degree of precision of the numerical quadrature. Numerical results are given for this kind of remedy in three test problems, including one with material discontinuities. It is shown how the use of orthonormal polynomials permits formulation of discrete-ordinates approximations that have properties like those of the highest-order spherical harmonic equations consistent with the number of directions in the discrete-ordinates approximation. It is found that these formulations also eliminate ray effects. It is concluded that the partially effective remedy of using more, specially chosen, directions is the most practical remedy for most applications, but that for especially difficult situations or for reference calculations, the defect-eliminating spherical harmonic-like formulations should be available for use. (auth)

49967 EFFECTIVENESS OF ACCELERATION TECHNIQUES FOR ITERATIVE METHODS IN TRANSPORT THEORY. Reed, W. H. (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng.; 45: No. 3, 245-54(Sep 1971).

The effectiveness of the acceleration techniques known as coarse-mesh rebalance and the synthetic method is examined for the iterative processes of transport codes. These two methods are shown to be equivalent in a certain sense. Analysis is presented in homogeneous slab geometry, which gives a necessary condition for the convergence of the synthetic method. Stable versions of these methods are developed, and numerical results comparing their effectiveness with that of Chebychev acceleration are presented. (auth)

49968 EMPIRICAL RELATION FOR AVERAGE ENERGY LOSS OF POSITRONS AND ELECTRONS. Batra, R. K.; Gupta, D. K.; Sehgal, M. L. (Aligarh Muslim Univ., India). pp 363-8 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

49969 MEASUREMENT OF CIRCULAR POLARIZATION OF GAMMA RAYS BY BACKSCATTERING FROM MAGNETIZED IRON. Palathingal, J. C. (Univ. of Cincinnati. Madras Christian Coll.). pp 429-32 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

49970 THICKNESS DEPENDENCE OF FORWARD EMITTED EXTERNAL BREMSSTRAHLUNG SPECTRUM PRODUCED IN LEAD BY THE BETA-PARTICLES OF ^{90}Sr-^{90}Y. Gopal, K.; Venkataramaiah, P.; Sanjeevaiah, B. (Univ. of Mysore, India). pp 433-7 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

49971 DEPENDENCE OF MULTIPLE SCATTERING OF COMPTON PHOTONS ON THE SIZE OF THE CYLINDRICAL SCATTERER. Sanjeevaiah, H.; Gopal, S.; Sanjeevaiah, B. (Univ. of Mysore, India). pp 438-41 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

Solid-State Physics

Refer also to abstract 50804.

49972 POSSIBILITY OF MAGNON INVESTIGATIONS WITHOUT A DIRECT ENERGY ANALYSIS USING A PULSED NEUTRON SOURCE. Dobrzynski, L. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Instrum. Methods; 95: No. 1, 45-8(1971).

The equation of the scattering surface is derived from the energy and momentum conservation laws for inelastic neutron scattering involving magnon creation or annihilation. From this equation some variants of the diffraction technique arise. Particular attention is paid to the studies made possible by pulsed reactors. (auth)

Radiation Effects

49973 (CEA-CONF-1764) ESR STUDY OF SEVERAL RADICALS IN GAMMA IRRADIATED FERROELECTRIC ARSENATES. Gaillard, J.; Lamotte, B. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1970. 8p. (CONF-700960–1). Dep. NTIS (U. S. Sales Only).

From sixteenth AMPERE colloquium: magnetic resonances and related phenomena; Bucharest, Romania (1 Sep 1970).

The ESR study of the $(AsO_4H_2)^{2-}$ radical in KDA and ADA single crystals revealed more information about the microscopic structure and dynamics of ferroelectrics in the KDP family: a new exchange effect in the paraelectric phase of KDA and ADA was observed and analyzed. The structure of the radical was reconsidered and demonstrated that exchange occurs between the upper and lower Slater configurations. The physical significance of these phenomena in relation with the ferroelectric soft modes is discussed. Several different Slater configurations of the radical were detected in the antiferroelectric phase of the ADA crystals. (France)

49974 (COO–2119-1) EXPERIMENTS IN HIGH VOLTAGE ELECTRON MICROSCOPY. Progress Report, October 31, 1970–July 31, 1971. Mitchell, T. E. (Case-Western Reserve Univ., Cleveland, Ohio. Div. of Metallurgy and Materials Science). 1 Aug 1971. Contract AT(11-1)-2119. 10p. Dep. NTIS.

Experiments are being conducted on high resolution selected area diffraction and in-situ electron radiation damage. The experiments include voids in a tungsten filament, crystallization in glass, and radiation damage in metals and calcium fluoride. (D.L.C.)

49975 (N–70-28588) RESEARCH STUDY OF STRUCTURAL DAMAGE PRODUCED IN SILICON SEMICONDUCTORS BY NEUTRON IRRADIATION. Semiannual Report. Sargent, Gordon A. (Kentucky Univ., Lexington. Dept. of Metallurgical Engineering and Materials Science). May 1970. Contracts NAS7-100; JPL-952561. 24p. (NASA-CR–110152). NTIS.

For Jet Propulsion Lab., Pasadena, Calif.

Techniques were established to etch and observe undoped and lithium-doped silicon solar cells by surface replication and by thin-film transmission electron microscopy. From preliminary surface and thin-film observations, it appears that a second-phase precipitate exists in the doped cells which has a bcc crystal structure and has a lattice parameter close to that of lithium. As lithium is the only bcc material present in any large amount, it seems reasonable to conclude that the precipitates are formed from excess lithium. (auth) (STAR)

49976 (N–71-16474) RESEARCH STUDY OF STRUCTURAL DAMAGE PRODUCED IN SILICON SEMICONDUCTORS BY NEUTRON IRRADIATION. Final Report, June 1969–July 1970. Sargent, Gordon A. (Kentucky Univ., Lexington. Dept. of Metallurgical Engineering and Materials Science). Jul 1970. Contracts NAS7-100; JPL-952561. 40p. (NASA-CR–116181; UKY–31-70-MET-13). NTIS.

For Jet Propulsion Lab., Pasadena, Calif.

The size distribution, morphology, and structural characteristics of the regions of lattice disorder produced by bombarding undoped and lithium-doped silicon solar cells with neutrons are discussed. The research was carried out entirely on the electron microscope using the techniques of surface replication, electron transmission, and electron diffraction. Evidence for the presence of precipitated metallic lithium was found in all the doped float-zone-melted samples, and there was some indication of an oxide precipitate in the pulled samples. Crater defects, thought to be associated with the space-charge region around vacancy clusters, were observed in all

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of the samples of the irradiated float-zone material. Similar defects were observed only in the most heavily doped and irradiated crucible pulled material. It was concluded that the presence of oxygen in the pulled material may be an efficient trap that prevents the formation of the large defect clusters. (auth) (STAR)

49977 LATTICE DISORDER IN ION-IMPLANTED BORON-DOPED SILICON. Hirvonen, J. K. (Rutgers–The State Univ., New Brunswick, N. J.). Appl. Phys. Lett.: 19: No. 1, 14-16 (1 Jul 1971).

The lattice disorder produced in 40 to 600-keV heavy ions implanted in undoped and heavily boron-doped silicon was measured using the channeling technique. The lattice disorder shows no significant dependence on the boron concentration of the implanted silicon for the variety of heavy ion species, doses, and implantation temperatures used. (auth)

49978 ESTIMATION OF DEFECTS IN GAMMA DEFECTOSCOPY. Kol'chuzhkin, A. M.; Uchaikin, V. V. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 1, 111-14(1971). (In Russian).

A method has been proposed for the calculation of the representation of defects of small dimensions. The results of such computation are presented for a series of defects of simple forms. (tr-auth)

49979 POLARIZATION IN MICAS AND THE INFLUENCE OF β IRRADIATION ON IT. Zavadovskaya, E. K.; Chernyshev, V. A.; Gol'd, R. M.; Podpletnev, V. I. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 1, 127-30(1971). (In Russian).

High-voltage polarization in micas was studied, together with the effect of β radiation on such phenomena. Construction of the apparatus permitted measurements to be made in a vacuum and over the temperature range 20 to 1100°C. The source of β particles was an electrostatic generator operating at 1 MeV and 1 μA. Samples included muscovite, biotite, and phlogopite. It was noted that the emf of high-voltage polarization in micas was quite significant up to 1000°C, a factor to be considered in dc conductivity measurements. Under the influence of β radiation, water was evolved from the mica crystals as a result of radiolysis, and molecular bonds were strengthened. This accounted for a decrease in the emf maximum of high-voltage polarization in the temperature range 850 to 900°C. (K.S.W.)

49980 ANNEALING OF RADIATION-INDUCED DECREASE OF CaF_2 CRYSTAL DENSITY. Ovcharov, A. T.; Kalinin, M. I.; Lisitsyn, V. M. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 1, 139-41(1971). (In Russian).

A study was made of an isochronous thermal annealing of the radiation-induced decrease in density and the decolorization of the absorption bands which result when CaF_2 crystals are irradiated with 4.5-MeV protons. The density annealing occurred at 180°C and the two types of absorption bands disappeared at 160 and 180°C, respectively. (K.S.W.)

49981 CRITICAL ANGLES OF Sb- AND Bi-IMPLANTED Si. Sigurd, D.; Domeij, B. (Research Inst. for Physics, Stockholm). Phys. Lett.; 36A: No. 2, 81-2(16 Aug 1971).

Complete angular scans in Sb- and Bi-implanted Si have shown that the widths of the channeling dips from scattering off impurity atoms are narrower than the widths of the dips from the Si host lattice. (auth)

49982 M_A^+ CENTER IN KCl. Schneider, Irwin (Naval Research Lab., Washington, D. C.). Solid State Commun.; 9: No. 1, 45-7(Jan 1971).

Absorption and emission bands of the M_A^+ (Na) center are identified and compared with the corresponding transitions of the M^+ center. The M_A centers were ionized either through a technique involving x irradiation followed by uv excitation, both carried out at liquid-He temperature, or simply by direct optical means. (TSS) (UK)

49983 MOTIONAL EFFECTS IN THE TRAPPED-HOLE CENTER IN SMOKY QUARTZ. Schnadt, R.; Raeuber, A. (Institut fuer Angewandte Festkoerperphysik, Freiburg i. B.). Solid State Commun.; 9: No. 2, 159-61(15 Jan 1971).

The thermal broadening of the ESR spectrum of the trapped-hole center in x-irradiated smoky quartz was investigated between 40 and 200°K. The activation energy for the hole-hopping process responsible was determined; W = (70 ± 10) MeV. This value is in order-of-magnitude agreement with those inferred from dielectric and anelastic loss measurements. (auth) (UK)

49984 EFFECT OF RADIATION ON MICROHARDNESS OF CaF_2. Zavadovskaya, E. K.; Ovcharov, A. T.; Lisitsyn, V. M. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 1, 149-52(1971). (In Russian).

One-mm thick samples were removed from a monocrystal of CaF_2 and irradiated with 4.5-MeV protons and with 1.2-MeV electrons at room temperature. The proton exposure increased the microhardness by 25 to 31%; the electron irradiation increased it by 7 to 10%. Absorption spectra tend to support the suggestion that radiation-induced hardening of CaF_2 crystals is linked with the presence of bivalent yttrium ions generated by a photochemical reduction of trivalent yttrium ions originally present in the crystals in very low concentration. (K.S.W.)

49985 INFLUENCE OF REACTOR IRRADIATION ON PROPERTIES OF THIN PERMALLOY FILMS. Lezhnenko, I. V. Fiz. Metal. Metalloved.; 30: No. 3, 555-9(Sep 1970). (In Russian).

The influence of reactor irradiation (10^{17} n/cm^2) on the field anisotropy, angular and amplitude dispersions of the field anisotropy, coercive force, magnetostriction, grain size, isotropic strain, demagnetization factor, and electric resistance of thin Permalloy films was studied. It was found that irradiation leads to significant changes of properties of the films. It is assumed that point defects, created on irradiation, are responsible for the changes. (tr-auth)

49986 DISLOCATION MOBILITY IN GAMMA-IRRADIATED SODIUM CHLORIDE CRYSTALS: REGION OF HIGH VELOCITIES. Ermakov, G. A.; Nadgornyi, E. M. (Inst. of Solid-State Physics, Chernogolovka, USSR). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 2, 410-14(Aug 1971).

Translated from Fiz. Tverd. Tela; 13: No. 2, 513-19(Feb 1971).

The speed v of screw dislocations is related to applied stress τ and temperature T (77–300°K) for $v > 10^3$ cm/sec in γ-irradiated NaCl crystals, for which $v(\tau)$ has previously been examined for small v. The motion at high v differs substantially from that at low v for alkali halides; the $v(\tau)$ differs in form, the trends in v(T) differ in sign, and the effects of point radiation defects are different. The motion is quasi-viscous for $v > 10^3$ cm/sec, and the effective viscosity B (0.15 – 0.5 mP) is dependent on T and the radiation dose. Also, B(T) indicates that phonon processes may delay motion in this range in v, and the effect appears to be of thermal-activation type, being related to diffusion attachment of the dislocation in this range of v, τ, and T. (auth)

49987 SURFACE SELF-DIFFUSION OF TUNGSTEN IN STRONG ELECTRIC FIELDS. Dranova, Zh. I.; Mikhailovskii, I. M. (Physical-Technical Inst., Kharkov). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 2, 443-6(Aug 1971).

Translated from Fiz. Tverd. Tela; 13: No. 2, 553-7(Feb 1971).

Field-emission microscopy is used to study the topography of acicular tungsten microcrystals bombarded by 500 to 5000-eV Ne and He ions. It is shown that the kinetics of microrelief changes is governed by surface migration processes. Formation of a W surface faceted by low-index planes, which is typical of high-temperature rearrangement in electric fields, was observed when tungsten crystals cooled to ~80°K were irradiated by Ne ions. It is assumed that activation of surface diffusion results from the development of localized radiative cascade collisions; the surface migration coefficient is calculated. (auth)

49988 ANNEALING OF RADIATION DEFECTS IN GAMMA-IRRADIATED NaCl CRYSTALS. Ermakov, G. A.; Nadgornyi, E. M. (Inst. of Solid-State Physics, Chernogolovka, USSR). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 2, 550-1(Feb 1971).

Translated from Fiz. Tverd. Tela; 13: No. 2, 660-2(Feb 1971).

The annealing kinetics of defects that retard dislocations was examined in γ-irradiated NaCl crystals (dose = 10^8 rad) by measuring the yield point τ before and after isochronous and isothermal anneals. There are two stages, a 40% reduction at 160 to 260°C and a return to the unirradiated value τ_0 at 300 to 360°C. The activation energies were determined to be 1.15 and 1.35 eV, and the reaction order was close to one. A picture of the annealing is given in which the defects responsible for most of the radiation hardening are clumps of interstitial anions, which are eliminated by migrating anion vacancies. At 290 to 360°C, single anion vacancies also rise. (D.L.C.)

49989 FIELD-ION MICROSCOPE INVESTIGATION OF LATTICE DEFECTS IN TUNGSTEN BOMBARDED WITH HIGH-ENERGY ELECTRONS. Garber, R. I.; Dranova, Zh. I.; Mikhailovskii, I. M.; Sidorenko, N. N.; Stratienko, V. A. (Physical-Technical Inst., Kharkov). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 2, 331-4(Aug 1971).

Translated from Fiz. Tverd. Tela; 13: No. 2, 406-10(Feb 1971).

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Radiation damage in tungsten bombarded with electrons of 250 MeV (integrated dose 5×10^{16} electrons/cm^2) was investigated by using field-ion microscopy. A histogram was established for the distribution of interstitials over the bulk of the irradiated material, their average concentration being of the order of 10^{18} cm^{-3}. Single interstitials were observed, as well as dumbbell configurations with a cleavage axis parallel to the [110] direction. Depleted regions with dimensions of 10 to 30 Å were detected with a periodicity corresponding to about 10^{-2} barn. (auth)

49990 TWO TYPES OF F CENTERS IN LiF CRYSTALS WHICH HAVE BEEN X-RAYED AT ROOM TEMPERATURE. Knab, G. G.; Urusovskaya, A. A. (Inst. of Crystallography, Moscow). Sov. Phys.-Cryst. (Engl. Transl.); 16: No. 1, 143-6(Jul-Aug 1971).

Translated from Kristallografiya; 16: No. 1, 181-5(Jan-Feb 1971).

Two maxima of the thermoluminescence and thermally stimulated electron emission were observed for spectroscopically pure LiF crystals which had been x-irradiated at room temperature. It was shown that these maxima correspond to two types of F centers that develop at point defects having different arrangements. Their respective thermal ionization energies are $E_1 = 1.22 \pm 0.05$ and $E_2 = 1.55 \pm 0.05$ eV. (auth)

49991 AMORPHISATION OF ION IMPLANTED CRYSTALS. Gerasimenko, N. N.; Dvurechenskii, A. V.; Smirnov, L. S.; Shirokov, E. G. (Inst. of Semiconductor Physics, Novosibirsk, USSR). Cryst. Lattice Defects; 2: No. 2, 125-6(May 1971).

Ion-implanted silicon crystals were investigated by means of ESR. The amorphous layer is formed near the crystal surface. The mechanism of the amorphization is discussed. (auth)

49992 KINETICS OF VACANCY-IMPURITY COMPLEXES BUILDUP IN SEMICONDUCTORS DURING IRRADIATION. Spitsyn, A. V. (Lebedev Inst. of Physics, Moscow). Cryst. Lattice Defects; 2: No. 2, 121-3(May 1971).

Almost unexplored so far, the situation where secondary radiation defects (vacancy + impurity) buildup can go simultaneously with the primary introduction is studied. All the necessary assumptions, allowing the use of rather simple mathematical approach to the vacancy-trapping phenomena, are carefully listed. An exact solution of the dependence of complex concentration on fluence is given, and two special cases of either low or high vacancy generation rate are analyzed in detail. (auth)

49993 LONG WAVELENGTH NEUTRON SCATTERING BY DEFECTS IN IRRADIATED GERMANIUM. Clark, C. D.; Mitchell, E. W. J.; Stewart, R. J. (Univ. of Reading, Eng.). Cryst. Lattice Defects; 2: No. 2, 105-20(May 1971).

Total neutron-scattering cross-section measurements were made on single crystals of germanium in the wavelength range 6 to 14 Å. Measurements were carried out before and after irradiation at 40°C with neutrons. The total dose was 1.01×10^{20} fast neutrons per cm^2 and 2.44×10^{20} thermal neutrons per cm^2. The defect scattering cross section shows a decrease with increasing wavelength above 6 Å, reaches its lowest value at about 13 Å, but has a distinct peak at 9.5 Å. An attempt to interpret this spectrum by computing the effects expected from a number of defect models is reported. It is concluded that the defects present in greatest concentration in germanium irradiated at 40°C are either divacancies or di-interstitial intrinsic defects at a concentration corresponding to 8.8×10^{19} displaced atoms per cm^3. The divacancy and di-interstitial models which give a good fit to the experimental results involve a complicated relaxation of the surrounding lattice over the first few nearest-neighbor shells. (auth)

49994 ANNEALING EFFECTS ON GALVANOMAGNETIC PROPERTIES OF HEAVILY RADIATION-DAMAGED GRAPHITE. Tsuzuku, Takuro; Arai, Shiro (Nihon Univ., Chiba, Japan). Tanso; No. 64, 3-10(Mar 1971). (In Japanese).

An annealing study of radiation damage in graphite was made through the observation of the changes in electric resistivity, Hall coefficient, and magnetoresistance at room and liquid-nitrogen temperatures. The specimen examined was a pile-grade polycrystalline graphite bombarded with fast neutrons at 30°C to total dose of 5.8×10^{20} nvt. The isothermal annealing was performed in a stepwise manner at temperatures from 200 up to 2400°C. The recovery diagrams are characterized by the presence of two major stages lying on the annealing temperature axis; a relatively small one around 300°C and a larger one around 1300°C. Based on a parabolic two-band representation of the electronic structure, thorough analyses were made of the data, which lead to a coherent description of the recovery process in terms of the following parameters: density and mobility of conduction carriers, overlap of upper and lower bands, and location of the Fermi level. Discussions are also given in relation to the defect structure. (auth) (Japan)

Physical Properties

Refer also to abstracts 49365, 49368, 49380, 49412, 49450, 49451, and 49534.

49995 (CONF-710712-1) MAGNETISM IN THE ACTINIDES. Brodsky, M. B. (Argonne National Lab., Ill.). [1971]. 10p. Dep. NTIS.

From Conference on rare earths and actinides; Durham, England (5 Jul 1971).

A review is presented of the magnetic properties of actinide metals, dilute alloys, NaCl-type compounds, and other intermetallic compounds. A bibliography of 45 references is included. (D.L.C)

49996 (CONF-710712-2) HYPERFINE FIELDS IN NaCl-TYPE ACTINIDE COMPOUNDS: THE CRYSTAL FIELD AND RELATIVISTIC EFFECTS. Chan, S.-K.; Lam, D. J. (Argonne National Lab., Ill.). Jun 1971. 4p. Dep. NTIS.

From Conference on rare earths and actinides; Durham, U. K. (5 Jul 1971).

A calculation is presented in which intermediate coupling angular wave functions are used to obtain the matrix elements of the orbital, spin–dipole, and spin terms of the hyperfine Hamiltonian. Hyperfine fields calculated for UP($5f^3$) and US($5f^4$) are compared with experimental results from Moessbauer experiments, but it is pointed out that the angular wave functions were fitted to spectroscopic, magnetization, and neutron data which were obtained from different samples. Both crystal-field and relativistic effects were taken into account. (D.L.C.)

49997 ELECTROLYTIC BEHAVIOR OF YTTRIA. Schieltz, Jon; Patterson, John W.; Wilder, D. R. (Ames Lab., Iowa). Contract W-7405-eng-82. J. Electrochem. Soc.; 118: No. 7, 1140-4(Jul 1971).

The electrolytic behavior of Y_2O_3 was investigated. Within the temperature range 700 to 1000°C, there is no electrolytic domain ($t_{ion} \geq 0.99$); however, a small ionic domain ($t_{ion} \geq 0.5$) does exist and is defined within the following boundaries: $\log P_{\oplus} = [11{,}030/T(°K)] - 15.84$ and $\log P_{\oplus} = [-35{,}300/T(°K)] + 15.59$. (auth)

49998 EFFECT OF TANTALUM ADDITIONS ON THE PROPERTIES OF NEW HIGH MAGNETIC PERMEABILITY ALLOYS NIMALLOY IN THE NICKEL AND MANGANESE SYSTEM. Masumoto, Hakaru; Murakami, Yuetsu; Hinai, Masakatsu (Research Inst. of Electric and Magnetic Alloys, Sendai). Trans. Jap. Inst. Metals; 12: No. 3, 153-8(May 1971).

Masumoto et al. have previously discovered that alloys in composition near Ni_3Mn exhibited a high permeability when developed to an optimum degree of order, and these alloys were named Nimalloy. In subsequent work on the effect of various additives on the properties of Ni–Mn alloys the highest initial permeability of 121,000 and the highest maximum permeability of 643,000 were obtained with Ni–Mn–Fe–Cr–Mo alloys. The results of Ta additions to Ni–Mn alloys show that, with increasing Ta content, the permeability of Ni–Mn alloys at first increases gradually, goes through a maximum rapidly, and then decreases gradually. The highest initial permeability of 20,470 is obtained on the alloy composed of 75.88% Ni, 19.47% Mn, and 4.65% Ta when cooled at a rate of 240°C/hr from 900°C and baked at 440°C for 64 hr, and the highest maximum permeability of 84,800 on the alloy of 75.37% Ni, 19.08% Mn, and 5.55% Ta when cooled at a rate of 240°C/hr from 900°C and baked at 440°C for 65 hr. The latter alloy shows a coercive force of 0.0253 Oe and a magnetic hysteresis loss of 50.85 erg/cm^3/cycle for the maximum magnetic induction of 5000 G, and its electrical resistivity being 52.7 μΩ-cm at 20°C. (auth)

49999 SOME PHYSICAL PROPERTIES OF THE TRANSITION METAL DIBORIDES. Samsonov, G. V.; Kovenskaya, B. A.; Serebryakova, T. I. (Kiev Polytechnic Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 1, 19-23(1971). (In Russian).

A number of electrophysical properties were determined for hot-pressed diborides of Ti, Zr, Hf, V, Nb, and Ta. The porosity of the specimens did not exceed 12%. Values were obtained for the specific electrical resistance, thermal emf, the relative expansion between 295 and 1300°K, and Hall's coefficient at room temperature. From these data the resistance coefficient and expansion coefficient were calculated. It is proposed that the B–B bonds in these diborides are covalent in character because of the sp valence electrons of B and the nonlocalized sd electrons of the metal. This theory agrees with NMR data which supports

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the presence in the B sublattice of not only σ but also π-bonds, the formation of which requires partial electron transfer from metal to boron. (K.S.W.)

50000 ELECTRIC RESISTANCE OF In–Ga–Sn TERNARY EUTECTIC AT MELTING POINT. Dutchak, Ya. I.; Prokhorenko, V. Ya.; Ratushnyak, E. A. (Lvov State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 7, 118-20(1970). (In Russian).

Precision measurements were made of specific electric resistance at the melting point, and the melting point entropy and electric conductivity were calculated using the substitution model. It was found that the calculated specific resistance of the In–Ga–Sn melt at 293°K was $\rho = 0.34 \times 10^{-4}$ ohm · cm; the experimental value was $\rho = 0.30 \times 10^{-4}$ ohm · cm. The agreement between the theoretical and experimental data confirmed the possibility of using the substitution model in a quasi-gaseous approximation of the given melt. It was confirmed that the In–Ga–Sn of eutectic concentration at 293°K is in the state of true physical solution. (R.V.J.)

50001 DYNAMIC EFFECTS OF LOCALIZED MAGNETIC MOMENTS ON NUCLEAR SPINS IN METALLIC SYSTEMS. Fradin, F. Y. (Argonne National Lab., Ill.). J. Phys. Chem. Solids; 31: No. 12, 2715-25(Dec 1970).

The nuclear spin–lattice relaxation rate of the nonmagnetic species in intermetallic compounds and alloys that possess localized moments is discussed in terms of the generalized dynamic susceptibility of the conduction electrons. The dynamic susceptibility is calculated from an interaction between conduction electrons obtained by Kim (NSA: 22, 17743), who used a canonical transformation to eliminate (to second order) the s–f (s–d) exchange interaction between conduction electrons and localized spins. The electron interaction obtained leads to a repulsion between electrons of opposite spins in the vicinity of the Fermi surface. The calculated nuclear spin–lattice relaxation rate has the form $1/T_1 = 1/T_{1K} + 1/T_{1f}$, where $1/T_{1K}$ is the Korringa relaxation rate and $1/T_{1f}$ is the relaxation rate due to the interaction between conduction electrons. The temperature dependence of T_{1f} is discussed for several cases. For intermetallic compounds based on a rare earth or an actinide element combined with a nontransition element, results for both Knight shift and T_1 are consistent with a large density of states at the Fermi level and a small (negative) effective s–f interaction. (auth) (UK)

50002 PECULIARITIES OF CHANGE OF ELECTRIC RESISTANCE IN DECOMPOSING ALLOYS Co–Nb AND Co–Ta. Chudakov, A. F.; Chuistov, K. V. (Inst. of Metal Physics, Moscow). Fiz. Metal. Metalloved.; 30: No. 3, 595-601(Sep 1970). (In Russian).

The change of electric resistance was studied in decomposing Co–2.4 at. % Ta and Co–2.2 at. % Nb over the entire temperature range of aging (300 to 1000°C). Both isothermal and isochronal annealings were conducted. According to the character of the change of electric resistance, the temperature range can be divided into three stages: first, a corresponding increase; second, a fast decrease; and third, again an increase in the electric resistance. (tr-auth)

50003 ENERGY BAND STRUCTURE OF BINARY ALLOYS OF VANADIUM WITH ELEMENTS AT THE END OF TRANSITION SERIES (Co, Ni, Rh, Pd, Ir, Pt). Nemnonov, S. A.; Kurmaev, E. Z.; Ishmukhametov, B. Kh.; Belash, V. P. (Inst. of Metal Physics, Sverdlovsk, USSR). Phys. Status Solidi (b); 46: No. 1, 77-82(1 Jul 1971).

The fluorescent V K_{β_2} emission bands from the pure metal and binary alloys of transition elements Co, Ni, Rh, Pd, Ir and Pt have been investigated. In the alloys V_3Rh, V_3Pd, V_3Ir, and V_3Pt the V K_{β_2} bands are split in two principal subbands. These spectrum changes are related to the energy separation of d-band components. (auth)

50004 INFLUENCE OF SULFUR SUBSTITUTION ON MAGNETIC PROPERTIES OF URANIUM MONOARSENIDE. Leciejewicz, J. (Inst. of Nuclear Research, Warsaw); Murasik, A.; Troc, R.; Palewski, T. Phys. Status Solidi (b); 46: No. 1, 391-5 (1 Jul 1971).

The magnetic properties of the UAs–US solid solution were studied using neutron-diffraction and magnetic methods. The low-temperature magnetic phase of UAs was found to be stabilized by the addition of sulfur in a wide range of temperatures and compositions. The transition to a ferromagnetic structure of US proceeds through a transient phase. Its magnetic structure was determined to be of longitudinal-static spin-wave type with co-sinusoidal modulation. Its periodicity is 2.5 a, where a is the lattice constant of a fcc crystallographic unit cell. (auth)

50005 LATTICE DYNAMICS OF THE HEXAGONAL CLOSE-PACKED METALS. Trott, A. J.; Heald, P. T. (Univ. of Surrey, Guildford, Eng.). Phys. Status Solidi (b); 46: No. 1, 361-8(1 Jul 1971).

A Born–Von Kármán model of the hexagonal close-packed lattice, which includes a combination of central and angular forces extending out to third nearest neighbors, is used to study the harmonic properties of beryllium, magnesium, and zinc. The phonon dispersion curves and frequency spectra of these metals are computed and compared with previous experimental and theoretical results. (auth)

50006 DIELECTRIC STUDY OF THE EUROPIUM–OXYGEN SYSTEM. Grosvald, G.; Dang Tran Quan; Bideau, D. (Univ., Rennes, France). Phys. Lett.; 36A: No. 3, 195-6(30 Aug 1971). (In French).

Dielectric relaxation was observed in nonstoichiometric europium oxides in the composition range Eu_3O_4–Eu_2O_3. (auth)

50007 OPTICAL THERMOREFLECTANCE IN V_2O_3. Shtorch, P.; Yacoby, Y. (Hebrew Univ., Jerusalem). Phys. Lett.; 36A: No. 2, 89-90(16 Aug 1971).

The thermoreflectance spectrum of V_2O_3 at room temperature is presented. The main features of the spectrum are discussed. (auth)

50008 DEPENDENCE OF ELECTRON TRAPPING TIME ON THE ELECTRIC FIELD IN SEMI-INSULATING CdTe. Canali, C. (Istituto di Fisica, Modena, Italy); Martini, M.; Ottaviani, G.; Zanio, K. R. Solid State Commun.; 9: No. 2, 163-6(15 Jan 1971).

The trapping time of electrons in semi-insulating CdTe was measured as a function of the electric field. An increase in the applied field from 3 to 30 kV/cm results in a corresponding increase in τ^+ from 3 to 30 nsec. (auth) (UK)

50009 MAGNETO-ELASTIC EFFECTS AND 3-mm MICROWAVE RESONANCE IN SINGLE-CRYSTAL 85Tb–15Y. Stanford, J. L.; Wagner, T. K. (Iowa State Univ., Ames). Phys. Rev., B; 4: No. 7, 2085-6(1 Oct 1971).

Ferromagnetic resonance at 102.5 GHz was observed in the rare-earth intermetallic alloy $Tb_{85}Y_{15}$, and the data were compared with the theory of Cooper, including the magneto-elastic effects in the frozen-strain model. Based on a Néel temperature of 204°K, parameters which give the best fit to the data are: axial anisotropy P_2S = 15.5°K/atom and magneto-elastic constant D^γ = 1.7°K/atom. These compare to the values for pure Tb: P_2S = 18.2°K/atom and D^γ = 1.7°K/atom. A physical explanation for the observed dependence of P_2S on the concentration of a nonmagnetic diluent (Y) is given. (auth)

50010 ONSAGER PHASE FACTOR IN CADMIUM. Coleridge, P. T.; Templeton, I. M. (National Research Council of Canada, Ottawa). Phys. Rev. Lett.; 27: No. 8, 507-8(23 Aug 1971).

Precise de Haas–van Alphen phase measurements for the lens orbit in Cd with the magnetic field in the basal plane show that the Onsager phase factor γ for this orbit is $\frac{1}{2}$ and not $\frac{3}{4}$ as predicted recently by Hosack and Taylor. A spin-splitting zero is observed in the $(10\bar{1}0)$ plane, giving a value for $g \approx 1.6$. (auth)

50011 NUCLEAR-ORIENTATION STUDIES OF LaCe, AuCe, AND AgCe. Flouquet, J. (CNRS, Orsay, France). Phys. Rev. Lett.; 27: No. 8, 515-17(23 Aug 1971).

$La^{137m}Ce$ alloys prepared by proton bombardment of La metal were studied by orientation of the ^{137m}Ce nuclei. From the variation of the anisotropy of the emitted γ rays with applied field, the Kondo temperature is estimated to be 0.1°K. AuCe and AgCe were also studied using the same technique. The results for the three systems are compared with those obtained by other methods. (auth)

50012 FREE-LATTICE–MODEL FERROMAGNETIC RESONANCE IN TERBIUM AT 24 GHz. Hart, L. W.; Stanford, J. L. (Ames Lab., Iowa). Phys. Rev. Lett.; 27: No. 10, 676-9(6 Sep 1971).

The results experimentally confirm free-lattice-model behavior in Tb at low microwave frequencies, as predicted by Vigren and Liu. The resonances below a temperature of 140°K were only observable when the external magnetic field was not precisely aligned along an a axis in the hexagonal plane of the sample. (auth)

50013 LONG-WAVELENGTH MAGNONS IN HEAVY RARE EARTHS: FREE OR FROZEN LATTICE. Vigren, D. T.; Liu, S. H. (Ames Lab., Iowa). Phys. Rev. Lett.; 27: No. 10, 674-6(6 Sep 1971).

It is shown that in the long-wavelength region the magneto-

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elastic effect allows both the free-lattice and the frozen-lattice mode to exist in the heavy rare earths Tb and Dy. The former may be more easily detected by ferromagnetic resonance at low frequencies and low temperatures, and the latter predominates at high frequencies and high temperatures. (auth)

50014 SURFACE FLUCTUATIONS AND SCATTERING OF SLOW NEUTRONS IN ANTIFERROMAGNETS. Akhiezer, I. A.; Syshchenko, V. G. (Kharkov State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 2, 462-6(Aug 1971).

Translated from Fiz. Tverd. Tela; 13: No. 2, 573-8(Feb 1971).

A theoretical study is made of surface fluctuations and of the scattering of slow neutrons in antiferromagnets accompanied by the excitation (or absorption) of surface plane waves. Expressions are obtained for correlation functions. These expressions contain terms that decrease with depth in a crystal and, therefore, they describe surface fluctuations. These terms have sharp maxima corresponding to the possibility of propagation of two types of surface spin waves in an antiferromagnet: optical and acoustic waves. Consequently, additional sharp maxima appear in the cross sections of slow neutrons and these represent the scattering of neutrons accompanied by the excitation of surface oscillations. (auth)

50015 OPTICAL AND ELECTRICAL PARAMETERS OF VANADIUM DIOXIDE IN A STRONG ELECTRIC FIELD. Valiev, K. A.; Kopaev, Yu. V.; Mokerov, V. G.; Rakov, A. V. Sov. Phys.-Solid State (Engl. Transl.); 13: No. 2, 342-3(Aug 1971).

Translated from Fiz. Tverd. Tela; 13: No. 2, 421-3(Feb 1971).

A semiconductor–metal phase transition occurs in a VO_2 crystal in a strong electric field. This was demonstrated from the reflection spectrum and the resistance as functions of field. The effect is interpreted as an inverse piezoelectric effect. (auth)

50016 ANNIHILATION RATE OF POSITRONS IN RARE EARTH METALS. Shrivastava, S. B.; Shrivastava, B. D.; Dubey, V. S. (Vikram Univ., Ujjain, India). Phys. Status Solidi (b); 46: No. 1, K47-50(1 Jul 1971).

Calculations were made of the positron annihilation rates of positrons in lanthanides, with the core annihilation from electrons in the 5s and 5p shells being taken into account together with the valence electron annihilation. The results are in good agreement with experimental values for the series La to Lu. (D.L.C.)

50017 EXPERIMENTAL STUDY OF ELECTRIC CONDUCTIVITY OF HIGHLY POROUS CARBON–GRAPHITE MATERIALS. Bel'skaya, E. A.; Tarabanov, A. S. (Inst. of High Temperatures, Moscow). Inzh.-Fiz. Zh.; 20: No. 4, 654-9(Apr 1971). (In Russian).

A potentiometric method is used to experimentally study electric conductivity of carbon–graphite materials with 19 to 80% porosity. The temperature investigated ranged from 300 to 1700°K. It is shown that the dependence of thermal and electric conductivities on porosity being expressed in generalized coordinates is the same within the whole of the temperature range under study. Within the porosity range from 19 to 55%, the experimental points are found to be fairly well governed by the Maxwell equation. (auth)

50018 FERRIMAGNETIC PROPERTIES OF PEROVSKITES OF THE TYPE $Sr_3U_{1-x}W_xFe_2O_9$. Bernier, J. C.; Seveque, F.; Delamoye, P.; Poix, P. (Institut de Chimie II, Orsay, France). Solid State Commun.; 9: No. 14, 1225-30(15 Jul 1971). (In French).

The distribution of the cations Fe^{3+} on the ferrimagnetic sublattices A and B in the solid solutions $Sr_3UFe_2O_9$–$Sr_3WFe_2O_9$ is deduced from the thermal variation of the magnetization. The molecular-field coefficients α, β, n of the theory of Neel are fitted to the experimental susceptibility and are found to be in the domain of stability of the zone Q. (auth) (UK)

50019 SPIN POLARIZATION OF CONDUCTION ELECTRONS IN Gd. Moon, R. M.; Koehler, W. C. (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett.; 27: No. 7, 407-10(16 Aug 1971).

Neutron-diffraction measurements on single crystals of ^{160}Gd were performed which allow the reconstruction, by Fourier synthesis, of the magnetization as a function of position. It is shown that the total magnetic moment density can be separated in a logical manner into a local part and a diffuse part. It is suggested that the local part corresponds to the 4f polarization and the diffuse part to the conduction-electron polarization. Contour maps show the diffuse contribution to be long-range and oscillatory. (auth)

50020 EFFECT OF THE DIFFRACTION OF ANNIHILATION γ RAYS ON THEIR ANGULAR CORRELATION IN A SINGLE CRYSTAL SPECIMEN. Hyodo, Toshio; Sueoka, Osamu; Fujiwara, Kunio (Tokyo Univ.). J. Phys. Soc. Jap.; 31: No. 2, 563-73 (Aug 1971).

A very sharp anisotropy of the angular correlation of annihilation radiation in a single-crystal specimen was found and investigated. It proved to be attributed to the diffraction of the annihilation photons by the lattice planes of the crystal. The experiment was performed by the rotating-specimen method as well as by the angular correlation method. The results showed that the diffraction of the annihilation photons makes a serious effect on the shape of the usual angular correlation curve and that the effect is very sensitive to the orientation of the crystal as expected. The integrated intensities of the diffraction peaks calculated by using the kinematical theory of x-ray diffraction were in a fairly good agreement with the experimental values. (auth)

50021 MAGNETIC PROPERTIES OF Co–Nb AND Co–Nb–Fe UNIDIRECTIONALLY SOLIDIFIED EUTECTIC COMPOSITES. Colling, D. A.; Kossowsky, Ram (Westinghouse Research Labs., Pittsburgh). Met. Trans.; 2: No. 6, 1523-7(Jun 1971). (CONF-691062–1).

From Symposium on properties of aligned eutectic composites; Philadelphia, Pa. (13 Oct 1969).

Eutectic composites of Co–Nb and Co–Nb–Fe were produced by unidirectional solidification. The structure consisted of aligned lamellae of $NbCo_3$ in a stabilized fcc cobalt-rich matrix. $NbCo_3$ lowered saturation induction, following a simple volume law of mixtures. Niobium in solid solution lowered both the saturation induction and the Curie temperature, whereas iron in solid solution raised the saturation induction while lowering the Curie temperature. A minimum in coercive force (H_{app} parallel to growth direction) occurred near 8 at. % Fe, attributable to a minimum in $|K_1|$ for this composition. (auth)

50022 ELECTRON–PHONON INTERACTION AND PARAMAGNETIC SUSCEPTIBILITIES FOR TRANSITION METALS. Mori, Nobuo (Shibaura Inst. of Tech., Tokyo). J. Phys. Soc. Jap.; 32: No. 2, 359-67(Aug 1971).

The influence of the electron–phonon interaction of the paramagnetic susceptibilities for transition metals is discussed. While the electronic specific heat is influenced by this interaction, the Pauli spin paramagnetic susceptibility and the orbital paramagnetic susceptibility are not influenced. In the case where the spin–orbit interaction exists, however, the spin paramagnetic susceptibility χ_s, the orbital paramagnetic susceptibility χ_{orb}, and the mixed contribution due to the spin and orbital angular momentums χ_{so} are influenced. In fcc 4d and 5d and hcp 5d transition metals, the modifications of χ_s, χ_{orb}, and χ_{so} due to the electron–phonon interaction are conceivable, but in other transition metals these modifications are very small. Finally, some discussions of this effect on the diamagnetic susceptibilities are given. (auth)

50023 CALCULATIONS OF ORBITAL PARAMAGNETIC SUSCEPTIBILITY FOR VANADIUM, CHROMIUM, AND IRON. Yasui, Masaru; Shimizu, Masao (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 31: No. 2, 378-81(Aug 1971).

The orbital paramagnetic susceptibilities for vanadium, chromium, and both paramagnetic and ferromagnetic irons are calculated by means of the Kubo and Obata formula. Band structures and wave functions, obtained self-consistently by combining the modified tight-binding and orthogonalized-plane-wave methods, are used. The temperature variations of the orbital paramagnetic susceptibility and the high-field susceptibility are also calculated, and the comparisons with experiments are discussed for vanadium and ferromagnetic iron. (auth)

50024 MAGNETOCRYSTALLINE ANISOTROPY OF RARE EARTH IMPURITIES DOPED IN GADOLINIUM. I. HEAVY RARE EARTH. Tajima, Keisuke (Gakushuin Univ., Tokyo). J. Phys. Soc. Jap.; 31: No. 2, 441-51(Aug 1971).

The magnetocrystalline anisotropy of the heavy-rare-earth impurities doped in gadolinium metal was measured by a torque method in a temperature range from 4.2 to about 200°K. The large contribution from the heavy-rare-earth impurities to the anisotropy is well explained by the crystal-field theory. The temperature dependence of the anisotropy constant can be explained fairly well by assuming that impurity moments behave paramagnetically in the exchange field produced by the host gadolinium. Anomalous bents were observed in torque curves at low temperatures for all the alloys except for Tm–Gd. (auth)

Moessbauer Effects and NMR

Refer also to abstracts 48959, 48964, and 48979.

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50025 INTRODUCTION TO MOESSBAUER SPECTROSCOPY. May, Leopold (ed.). New York; Plenum Press (1971). 211p.

This book explains the basic concepts of the Moessbauer effect, reviews instrumentation, and discusses new applications of Moessbauer spectroscopy in such areas as solid-state physics, coordination chemistry, organometallic compounds, physical metallurgy, and biochemistry. A nomenclature and a bibliography of sources and references are included. (D.L.C.)

50026 INFLUENCE OF ULTRASONIC EXCITATIONS IN CRYSTALS ON THE PROBABILITY OF THE MOESSBAUER EFFECT. Aivazyan, G. M.; Aivazyan, Yu. M.; Gol'danskii, V. I.; (and others) (Inst. of Chemical Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 13: No. 10, 388-90(20 May 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 13: No. 10, 543-6(20 May 1971).

It was found experimentally that the excitation of acoustic oscillations in an absorber containing Moessbauer nuclei leads to a change in the parameters of the Moessbauer absorption spectra and to the appearance of strong anisotropy of the probability of the Moessbauer effect. This apparently makes it possible to investigate certain subtle physical phenomena occurring in crystals. (L.M.T.)

Theoretical Physics

50027 (CONF-690732) 4th SEMINAR ON THEORETICAL PHYSICS, JOHANNESBURG, JULY 7–11, 1969. (University of the Witwatersrand, Johannesburg (South Africa)). Nov 1969. 264p. (In several languages).

Fifteen lectures are presented on solid state theory, relativity theory, astrophysics and cosmology, and nuclear and particle physics. Separate abstracts are prepared for 12 of the 15 lectures. (C.E.S.)

For abstracts of individual lectures see: 49597, 49687–49689, 49754, 50028, 50029, 50089, 50145, 50166, 50802, and 50803.

50028 (CONF-690732, pp 5.1-18) MODERN FORMALISM IN TENSOR CALCULUS. Kaniuk, G. (University of the Witwatersrand, Johannesburg (South Africa)).

From fourth seminar on theoretical physics; Johannesburg, South Africa (7 Jul 1969).

This paper is essentially an outline of the elements of modern differential geometry, simplified for the needs of relativity. An attempt is made to present the essential ideas, and thus there is a strong emphasis on motivation rather than rigorous detail. (W.D.M.)

50029 (CONF-690732, pp 221-55) INVARIANT THEORY OF VARIATIONAL PROBLEMS FOR GEOMETRIC OBJECTS. Rund, H. (University of the Witwatersrand, Johannesburg (South Africa)).

From fourth seminar on theoretical physics; Johannesburg, South Africa (7 Jul 1969).

An invariant problem in the calculus of variations is considered, in which the dependent functions are components of a geometric object, or, more precisely, the components of entities that satisfy the usual transformation law of convection coefficients. One of the objects of such a theory is to provide a theoretical basis for methods of deriving the gravitational field equations of Einstein from variational principles. This aim is achieved, although one has to consider the combined effect of two sets of Euler–Lagrange equations resulting from two distinct special Lagrangians. (W.D.M.)

50030 (LA-DC-12360) LEAST STRUCTURE TECHNIQUE IN UNFOLDING. Young, C. S. (Los Alamos Scientific Lab., N. Mex.). [1971]. 46p. (CONF-710606-9). Dep. NTIS.

From seventeenth annual meeting of the American Nuclear Society; Boston, Mass. (13 Jun 1971).

A refinement of the least-square technique for data unfolding is described and applied to the Trail–Raboy response function, a time pulse from a very long coaxial cable, and two-dimensional unfolding of a linear array of detectors. (W.H.K.)

50031 SECOND APPROXIMATION OF THE GENERALIZED WKB METHOD. VI. AN APPLICATION TO AN INVESTIGATION OF POTENTIAL SCATTERING OF RELATIVISTIC ELECTRONS. Zhirnov, N. I. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 1, 72-81(1971). (In Russian).

Using the generalized WKB method, the phase shifts of wave functions of relativistic electrons were investigated, the electrons being scattered by a statistical centrally symmetric field. From the calculation of the relativistic phase of scattering, a formula was obtained that corresponds to the second approximation of the generalized WKB method. In order to illustrate the applicability of the method, the author examined the elastic scattering of electrons by a Coulombic field and by a Gaspar potential field. (K.S.W.)

50032 TOTAL POWER OF TRANSITION RADIATION BY A CHARGE MOVING IN ELECTROMAGNETIC FIELDS OF A SPECIAL KIND. Bordovitsyn, V. A. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 1, 131-2(1971). (In Russian).

The radiation by a charge moving through mutually perpendicular electric and magnetic fields is investigated for the case where one coordinate coincides with the direction of the electric field. Knowing the interval of motion, it is possible to ascertain precisely the power of the instantaneous radiation generated by the charge, in this case and in the general case. (K.S.W.)

50033 GENERALIZED ORTHOGONAL COORDINATES FOR CHARGED-PARTICLE TRAJECTORIES IN AN ELECTROMAGNETIC FIELD. Malov, A. F. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 2, 191-4(Aug 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 2, 252-8(Feb 1971).

The trajectories of charged particles in inhomogeneous electromagnetic fields have been investigated at great length. In certain fields it can be more convenient to use an arbitrary orthogonal curvilinear coordinate system rather than rectangular or cylindrical systems. Kel'man and Yavor earlier derived the equations of motion of charged particles in electromagnetic fields in a general coordinate system but, trajectory equations with the time parameter eliminated have not yet been obtained. In the present work, these equations are derived. (auth)

50034 SPECTRAL-FUNCTION SUM RULES FOR HARD-CORE POTENTIALS. Kleban, Peter (Inst. Laue-Langevin, Grenoble, France). Phys. Rev. Lett.; 27: No. 10, 657-60(6 Sep 1971).

It is shown that the third frequency moment of the dynamic density–density correlation function $\chi''(k,\omega)$ diverges for quantum and classical systems with hard-core potentials. Some information is obtained about the leading term of the divergence in the hard-core limit. (auth)

50035 BOUNDARIES OF STABILITY OF SPATIALLY HOMOGENEOUS DISTRIBUTION IN THE SYSTEM OF PARTICLES WITH DEPRESSION IN INTERACTION POTENTIAL. Zryakov, I. N.; Mozol'kov, A. E. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 11: No. 2, 116-25(Mar-Apr 1970). (In Russian).

In earlier studies Vlasov investigated a system of particles with a depression in the interaction potential. Here, the conditions for realization or violation of uniform distribution of the particles in such a system are studied. Comparison is made with experimental data. (tr-auth)

50036 CALCULATION OF FREE ENERGY IN THE CASE OF THE THIRRING MODEL. Bogolyubov, N. N.; Shumovskii, A. S. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 11: No. 2, 161-7(Mar-Apr 1970). (In Russian).

The asymptotic equivalence of the free-energies model and approximating Hamiltonians is shown for the Thirring model. (tr-auth)

50037 COVARIANT STEPS AND EXPONENTIAL DISTRIBUTION FUNCTIONS. Podosenov, P. B. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 11: No. 2, 195-9(Mar-Apr 1970). (In Russian).

Two steady-state solutions were obtained for the widely covariant equations of continuity for the distribution function $F(x^\alpha u^\alpha)$ ($\alpha = 0, 1, 2, 3$). The power law of distribution is used in the case of cosmic rays, and is exponential in the case of uniform distribution of stars according to velocity. (tr-auth)

50038 DYNAMICS OF NEUTRALIZED ELECTRON BEAMS. Bosamykin, V. S. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 3, 419-22(Sep 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 3, 539-44(Mar 1971).

The paraxial motion of a relativistic cylindrical electron beam with a constant degree of neutralization that moves through a uniform longitudinal magnetic field is treated. A general solution of the equation of motion of an edge electron is derived; the linear approximation for the case of low-amplitude ripples of the edge of the beam relative to the equilibrium radius is also treated. Relations for determining the profile of the neutralized beam in space free of externally applied fields are derived; the distance to the point of maximum contraction is determined as a function of the energy, current, and degree of neutralization. The boundary of the neutralized beam is found in the linear approximation for

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the case of electron motion through an acceleration region with a uniform electric field. All of the special cases considered here are illustrated by numerical solutions of the corresponding general equations for selected values of dimensionless parameters. (auth)

50039 WHERE SEMICLASSICAL RADIATION THEORY FAILS. Nesbet, R. K. (IBM Research Lab., San Jose, Calif.). Phys. Rev. Lett.; 27: No. 9, 553-6(30 Aug 1971).

Semiclassical radiation theory provides parallel derivations of spontaneous emission and of spontaneous incoherent scattering of radiation. In the latter case, in contrast to the former, the theory is in clear disagreement with established experimental data since it predicts equal intensity for Stokes and anti-Stokes lines in Raman scattering. A new postulate of semiquantization is proposed to restore agreement with experiment without quantizing the electromagnetic field. (auth)

50040 GENERAL APPROACH TO NONEQUILIBRIUM QUANTUM STATISTICS. Pike, E. R.; Swain, S. (Royal Radar Establishment, Great Malvern, Eng.). J. Phys., A (London); 4: No. 4, 555-63(Jul 1971).

Direct use of a generalized Laplace transform is proposed for applications in nonequilibrium quantum statistics. The method includes the equilibrium "double-time" Green's function method as a special case. An example is given in optical theory in which non-Markoffian behavior and Poincaré recurrences were explicitly found. (auth) (UK)

50041 COHERENT RESONANCE SCATTERING OF A NONMONOCHROMATIC IMPULSE BY AN ATOM. Melikyan, A. O. (Inst. of Physical Research, Erevan). Dokl. Akad. Nauk Arm. SSR; 51: No. 4, 214-18(1970). (In Russian).

A particle with a given carrier frequency and spectral width is assumed to be scattered by an atom with two specified energy levels, between which the transition is permitted. A conditional relationship is developed, the fulfillment of which would provide for supression of the scattering at the resonance frequency. (K.S.W.)

50042 COMPLEX METHODS FOR THREE-DIMENSIONAL MAGNETIC FIELDS. Beth, Richard A. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 901-3(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A typical three-dimensional problem is to find the magnetic field off the end of a finite current multipole, i.e., a circular cylinder of finite length having a cos $n\varphi$ current distribution along its elements. The corresponding two-dimensional problem of finding the magnetic field both inside and outside of such a current 2n-pole of infinite length can be concisely solved by complex methods. A method of systematically extending complex methods to three dimensions is described. The current multipole example is used to illustrate some of the features of the method. The results are given in closed form and involve complete elliptic integrals of all three kinds. (auth)

50043 SOME CRITICISMS OF QUANTUM LOGIC. Ingleby, M. (Univ. of Sussex, Brighton, Eng.). Helv. Phys. Acta; 44: No. 3, 299-307(15 May 1971).

It is argued that the division ring (sfield) obtained by C. Piron (Helv. Phys. Acta, 37: 439(1964)) after imbedding a coherent lattice of propositions (questions) in a projective geometry is a lower bound on the division ring of coefficients over which a quantum-mechanical Hilbert space must be constructed. Using the first four of G. W. Mackey's six axioms preceding his adoption of von Neumann's quantum mechanics in his seventh axiom, a Hilbert space over any sfield is constructed. Then, observables are represented as projection-valued measures, and certain states are represented as rays. (auth)

50044 MAGNETIC DIFFUSION IN CYLINDRICAL GEOMETRY. Herlach, Fritz (Illinois Inst. of Tech., Chicago). Helv. Phys. Acta; 44: No. 3, 308-20(15 May 1971). (In German).

The diffusion of magnetic flux in conductors is discussed with a view to cylindrically imploding megagauss generators. Simple analytical expressions are developed that are adequate for a precise analysis of most experiments. It is shown that, in many cases, a suitable plane approximation can be used instead of the exact cylindrical solution. For the field at the surface of the conductor, an exponential field rise is assumed. Deviations from this in actual experiments are treated by a superposition of the basic exponential solutions. The change of the resistivity due to Joule heating is discussed in terms of Bryant's solution of the nonlinear diffusion equation. The concept of the flux diffusion speed is developed, and it is shown that the diffusion of magnetic flux into the conductor depends essentially on the resistivity at the surface. The partition of the energy flow into magnetic and Joule energy is analyzed, and a differential equation is derived which governs field distributions with equipartition between these energies. Applications are discussed and practical examples are given. (auth)

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PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 50232.

50045 (ORO–2504-174) PROGRESS REPORT [ON HIGH ENERGY PHYSICS], 1970–71. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Contract AT(40-1)-2504. 45p. Dep. NTIS.

Summaries of research on experiments in high-energy physics are given. A list of publications is included. (J.F.P.)

Electromagnetic

Refer also to abstracts 49011, 50455, 50456, 50464, 50579, and 50737.

50046 DETERMINATION OF THE PHOTOPRODUCTION PHASE OF ϕ MESONS. Alvensleben, H.; Becker, U.; Busza, W.; (and others) (Massachusetts Inst. of Tech., Cambridge. Deutsches Elektronen-Synchrotron, Hamburg). Phys. Rev. Lett.; 27: No. 7, 444-8(16 Aug 1971).

Wide-angle electron–positron pairs from the reaction $\gamma + C \rightarrow C + e^+ + e^-$ were measured in the invariant-mass region $920 < m < 1080$ MeV/c^2 for incident photon energy $6 < k < 7.4$ GeV. The photoproduction amplitude of the ϕ meson was found to deviate from pure imaginary by $25° \pm 15°$, this deviation corresponding to a ratio of the real to imaginary part of the ϕ–nucleon amplitude of $\beta = -0.48^{+0.13}_{-0.14}$. The forward photoproduction cross section $[d\sigma(\gamma + C \rightarrow C + \phi(\phi \rightarrow e^+e^-))dt]_{t=0}$ was found to be 96 ± 14 nb/(GeV/c)^2. (auth)

50047 ELASTIC ELECTRON–DEUTERON SCATTERING AND THE ELECTRIC NEUTRON FORM FACTOR AT FOUR-MOMENTUM TRANSFERS 5 fm$^{-2} < q^2 < 14$ fm^{-2}. Galster, S. (Technische Hochschule, Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.); Klein, H.; Moritz, J.; (and others). Nucl. Phys.; B32: No. 1, 221-37(1971).

The cross section for elastic electron–deuteron scattering was measured for ten four-momentum transfers squared in the range 5 fm$^{-2} < q^2 < 14$ fm^{-2}. From the measured cross sections the sum $A(q^2)$ of charge and quadrupole form factors was determined. The experimental values are compared with theoretical predictions including relativistic corrections. Different deuteron wave functions and different parametrizations for the electric neutron form factor G_{EN} were used. The best fit to the experimental data was found with the wave function of Feshbach–Lomon and the parametrization: $G_{EN}(q^2) = -(\mu N/1 + 5.6\tau)G_{EP}(q^2)$, $\tau = q^2/4M^2$. (auth)

50048 ELECTROPRODUCTION OF π^0 MESONS IN THE REGION OF THE FIRST PION–NUCLEON RESONANCE. Hellings, R. D. (Lancaster Univ., Eng.); Allison, J.; Clegg, A. B.; (and others). (Nucl. Phys.; B32: No. 1, 179-88(1971).

The reaction $e^- + p \rightarrow e^- + p + \pi^0$ was studied in the π–N centre of mass range from 1130 to 1340 MeV/c^2 by detecting the final proton in coincidence with the scattered electron. The four-momentum transfer to the pion–nucleon system was between 0.40 and 0.50 (GeV/c)^2 and the polarization of the exchanged virtual photon near unity. The proton angular distribution is analyzed phenomenologically in terms of the multipoles M_{1+}, E_{1+}, S_{1+} contributing to the resonant partial wave and E_{0+}, S_{0+} contributing to the s-wave background. The magnetic dipole excitation M_{1+} is shown to dominate the cross section but clear evidence is obtained for a significant contribution from the scalar multipole S_{1+}. (auth)

50049 ELECTROPRODUCTION OF $\pi^+\Delta^0(1236)$ ON HYDROGEN. Driver, C.; Heinloth, K.; Hoehne, K.; (and others) (DESY, Hamburg). Nucl. Phys.; B32: No. 1, 45-65(1971).

The electroproduction of a π^+ meson and of the $\Delta^0(1236)$ nucleon resonance on hydrogen, $ep \rightarrow e'\pi^+\Delta^0(1236)$, was investigated by measuring the scattered electron and the produced π^+ meson in coincidence. The differential cross sections as functions of the four-momentum squares of the $\pi^+\Delta^0$ system, of the virtual photon, and of the nucleon recoil were determined. (auth)

50050 COMPARISON OF MUON–PROTON AND ELECTRON–PROTON DEEP INELASTIC SCATTERING. Toner, W. T. (Stanford Univ., California); Braunstein, T. J.; Lakin, W. L.; (and others). Phys. Lett.; 36B: No. 3, 251-6(6 Sep 1971).

As a test of muon-electron universality, muon–proton and electron–proton inelastic scattering cross sections were compared for $|q^2|$ (square of the four-momentum transferred from the lepton) values up to 4.0 (GeV/c)^2 and for lepton energy losses up to 9 GeV. There is no experimentally significant deviation from muon–electron universality. If the muon is assigned the form factor $(1.0 + |q^2|/\Lambda_d^2)^{-1}$ relative to the electron, then with 97.7% confidence $\Lambda_d > 4.1$ GeV/c. (auth)

50051 FORMATION OF HAMMER TRACKS DURING INTERACTION OF γ QUANTA WITH ENERGIES UP TO 1.1 GeV WITH NUCLEI OF PHOTOEMULSIONS. Mameev, V. V.; Filimonov, V. A. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 11, 124-6(1970). (In Russian).

A search for hammer tracks was conducted in type BR-2 emulsion after photospallation by the bremsstrahlung of the synchrotron Sirius. The emulsion layer was placed perpendicular to the axis of the γ-beam in order to reduce the background from electron–positron pairs. For lengthwise orientation of the emulsion layers the background decreases the effectiveness of examination. Collimation of the γ beam produces an exposure area of 7.5 cm^2. Exposure is measured with a Wilson quantum meter, and is conducted at two energy maxima of bremsstrahlung: 700 and 1100 MeV. (tr-auth)

Weak

Refer also to abstracts 50457 and 50458.

50052 (NEVIS–187) MEASUREMENT OF THE K_1^0 BRANCHING RATIO. Cooper, William A. (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.). 1971. Contract AT(30-1)-1932. 134p. (CU–291; R–756). Dep. NTIS.

Thesis.

The fraction of K^0 production which decays in the mode $K_1 \rightarrow \pi^+\pi^-$ was measured to be 0.345 ± 0.005. From this, the K_1 branching ratio R = (rate for $K_1 \rightarrow \pi^+\pi^-$)/(rate for $K_1 \rightarrow \pi^0\pi^0$) is found to be 2.23 ± 0.10, in disagreement with the $\Delta I = \frac{1}{2}$ rule prediction $R = 2.0$. A comparison with $K^+ \rightarrow \pi^+\pi^0$ decays, where the $\Delta I = \frac{1}{2}$ rule violation is comparable to that observed in K_1 decays, shows that no $\Delta I = \frac{5}{2}$ component is required by the data, and upper limits to its contribution can be set under various assumptions. Assuming $\Delta I = \frac{5}{2}$ to be absent, the difference between the $I = 2$ and $I = 0$ strong interaction phase shifts at the K mass is found to be 46^{+18}_{-30}°. (auth)

50053 (PURC–4159-39) EXPERIMENTAL STUDY OF THE τ DECAY. Ford, W. T.; Piroue, P. A.; Remmel, R. S.; Smith, A.J.S.; Souder, P. A. (Princeton Univ., N. J. Joseph Henry Labs.). [1971]. Contract AT(30-1)-4159. 23p. Dep. NTIS.

Preliminary results based on ~650,000 reconstructed $K^+ \rightarrow \pi^+\pi^+\pi^-$ events and an equal number of Monte Carlo events yield the following for the square of the matrix element: linear fit: $|M|^2 = 1 + (0.273 \pm 0.006)Y$, and quadratic fit: $|M|^2 = 1 + (0.279 \pm 0.006)Y + (-0.031 \pm 0.030)X^2 + (0.029 \pm 0.014)Y^2$. The analysis is continuing and more complete results will be presented. (auth)

50054 (RISO–226) FREE NEUTRON BETA-DECAY HALF-LIFE. Christensen, C. J.; Nielsen, A.; Bahnsen, A.; Brown, W. K.; Rustad, B. M. (Danish Atomic Energy Commission, Risoe. Research Establishment). Mar 1971. 57p. Dep. NTIS (U. S. Sales Only).

The beta-decay half-life of the free neutron was measured. Greater accuracy was obtained through the development of a special $4\pi\beta$-spectrometer with a well-defined source volume and through the use of a new density calibration method with a ^{3}He proportional counter. A clean, thermal-neutron beam was developed especially for the measurement. The final result is a half-life of 10.61 ± 0.16 min. The derived value of g_A/g_V is -1.239 ± 0.011. (auth)

50055 EXPERIMENTAL STUDY OF THE DECAY RATE, FORM FACTORS, AND $\pi\pi$ PHASE-SHIFT IN K^+_{e4} DECAY. Schweinberger, W. (Technische Hochschule, Aachen); Bertrand, D.; Czejthey-Barth, M.; (and others). Phys. Lett.; 36B: No. 3, 246-50(6 Sep 1971).

A sample of 115 $K^+_{e4}(e^+)$ decays was obtained in a heavy liquid

bubble chamber. The decay rate is given, together with the form factors and mean $\pi\pi$ phase-shift as determined by a maximum likelihood method. (auth)

Strong (Baryon-Induced)

Refer also to abstract 50219.

50056 (AD–721714) COSMIC-RAY INTERACTIONS AT 10^{11} TO 10^{13} eV. Cowan, E. W.; Matthews, K. (California Inst. of Tech., Pasadena. Dept. of Physics). 1971. Contract Nonr-220(53). 30p. NTIS.

A sample of 1167 single cosmic rays near sea level is analyzed from the data recorded by an interleaved stack of cloud and ionization chambers, and carbon and iron plates. The results include loss-rate curves in iron and carbon, mean free path in carbon, and energy spectra of charged hadrons (largely pions) and neutrons. (auth) (USGRDR)

50057 (JINR–E1-5935) A SEARCH FOR RESONANCES OF B = 2,3 AND S = 0, -1, -2. Shakhbazyan, B. A.; Timonina, A. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1971. 21p. Dep. NTIS (U. S. Sales Only).

The effective mass spectra of (Λp), ($\Lambda\Lambda$), (pp) and (ppΛ) systems were investigated. In the (Λp) mass spectrum significant peaks at 2058, 2127 and 2252 MeV mass values were observed. (auth)

50058 (JINR–P-1-5916) SEARCH FOR BARYON RESONANCES IN pγ SYSTEM. Budagov, Yu. A.; Vinogradov, V. B.; Volodko, A. G.; Dzhelepov, V. P.; Kladnitskii, V. S.; Koutsidi, N. K.; Lomakin, Yu. F.; Martinska, G.; Flyagin, V. B.; Shandor, L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 6p. (In Russian). Dep. NTIS (U. S. Sales Only).

The results of the search for nucleon state predicted in the range of $M_N < M_{N'} < M_N + M_\pi$ masses which decays by the scheme $N' \rightarrow p + \gamma$ are reported. The upper limit for this state production cross section in the reaction $\pi^- p \rightarrow \pi^- N' (N' \rightarrow p\gamma) + k\pi^0$, $k \geq 1$ was obtained at 5 GeV/c. The experiment was performed using the one-meter propane bubble chamber of the Joint Institute for Nuclear Research. (auth)

50059 (PURC–4159-35) NEUTRON–PROTON CHARGE-EXCHANGE SCATTERING FROM 8 TO 28 GeV/c. Davis, Michael B.; Gibbard, Bruce G.; Kreisler, Michael N. (Princeton Univ., N. J. Joseph Henry Labs.); Dobrowolski, T.; Longo, Michael J.; McCorriston, Thomas P.; O'Brien, Donald D. (Michigan Univ., Ann Arbor. Dept. of Physics); Toohig, Tim (Brookhaven National Lab., Upton, N. Y.). Jul 1971. 15p. (UM-HE-71-28; CONF-710810–1). Dep. NTIS.

From Meeting on particles and fields; Rochester, N. Y. (30 Aug 1971).

Preliminary results of a measurement of differential cross sections for the process $n + p \rightarrow p + n$, with incident neutrons in the 8 to 28 GeV/c momentum range are presented. The neutron beam was obtained at 0° from the Be target in the external proton beam at the A.G.S. Measurements were made of the momentum and angles of both the high energy proton and the recoil neutron, thus allowing a three-constraint fit for elastic events. Angular distributions are presented for $0.002 \leq |u| \leq 1.0$ (GeV/c)^2 based on ≈23,000 events. (auth)

50060 (PURC–4159-36) NEUTRON TOTAL CROSS SECTIONS ON PROTONS AND NUCLEI IN THE 10 TO 30 GeV/c MOMENTUM RANGE. Jones, Lawrence W.; Longo, Michael J.; McCorriston, Thomas P.; Parker, Everette F.; Powell III, Smith T. (Michigan Univ., Ann Arbor. Dept. of Physics); Kreisler, Michael N. (Princeton Univ., N. J. Joseph Henry Labs.). Jul 1971. 14p. (UM-HE-71-27; CONF-710810–2). Dep. NTIS.

From Meeting on particles and fields; Rochester, N. Y. (30 Aug 1971).

The results of a recent AGS measurement of the total cross section for neutrons on protons, deuterons, and other nuclei in the momentum range 10 to 30 GeV/c are presented. The standard good-geometry transmission technique was used with a total absorption spectrometer to detect the transmitted neutrons. Biasing the spectrometer towards high neutron momenta together with the strongly peaked momentum spectrum of the beam gave relatively good momentum resolution. Measurements were made at mean momenta of 12, 13, 18 and 26.5 GeV/c. Results are presented and compared with other data, and the momentum dependence of the cross sections is discussed. (auth)

50061 SEARCH FOR STRUCTURE IN THE NUCLEON ISOBAR MASS SPECTRUM FROM 1100 TO 1800 MeV. Ellis, W. E.; Maglic, B.; Norem, J.; Sannes, F.; Silverman, M. (Rutgers–The State Univ., New Brunswick, N. J.). Phys. Rev. Lett.; 27: No. 7, 442-4(16 Aug 1971).

A new high-resolution (±5 MeV) missing-mass spectrometer was used to search for minor peaks and structure in the N* spectrum with ~10^5 events per 2-MeV mass bin. All the widths were found to be narrower than widths obtained from πp phase-shift analyses; for example, the result for N*(1512) is $\Gamma = 88 \pm 2$ MeV as compared with the "table value" of 105 to 155 MeV. No narrow structure greater than 5% of the cross section for the known peaks was observed. (auth)

50062 NON-ANNIHILATION CHANNELS IN $\bar{p}$p INTERACTIONS NEAR CENTRE OF MASS ENERGY 2200 MeV. Bacon, T. C. (Rutherford High Energy Lab., Chilton, Eng.); Butterworth, I.; Miller, R. J.; (and others). Nucl. Phys.; B32: No. 1, 66-74(1971).

The elastic and one-pion production channels from the $\bar{p}$p interaction at four c.m. energies between 2150 and 2240 MeV are described. No evidence of formation of the narrow T(2195) meson is observed. The elastic differential cross section is measured in the range of squared four-momentum transfer $|t| > 0.03$ GeV^2. This has been extrapolated to the forward direction where Re/Im parts of the amplitude are deduced. The one-pion final states are well described by assuming that they are dominated by Δ-production. (auth)

50063 ANTIPROTON–PROTON ELASTIC SCATTERING FROM 1.51 TO 2.90 GeV/c. Parker, D. L.; Oh, B. Y.; Smith, G. A.; Sprafka, R. J. (Michigan State Univ., East Lansing). Nucl. Phys.; B32: No. 1, 29-44(1971).

In a bubble chamber experiment, $\bar{p}$p elastic scattering was measured at nine momenta in the range 1.51 to 2.90 GeV/c. The extrapolation of the small angle region to t = 0 is discussed and compared with results of other experiments. The differential cross sections are fitted to an adaptation of the Frahn–Venter optical model and also compared to Regge-pole model predictions. (auth)

50064 SLOPE PARAMETER AND RATIO OF THE REAL TO THE IMAGINARY PART OF THE FORWARD AMPLITUDE OF THE ELASTIC PROTON–PROTON SCATTERING AT 30, 50, AND 70 GeV. Chernev, Kh. N.; Geshkov, I. M.; Ikov, N. L.; Markov, P. K.; Zaiachki, V. I. (Inst. of Physics, Sofia). Phys. Lett.; 36B: No. 3, 266-8(6 Sep 1971).

The differential cross sections in the range of four momentum transfer squared from 0.003 to 0.120 (GeV/c)^2 were measured at 30, 50, and 70 GeV by using a thin polyethylene target in the internal proton beam of the Serpukhov accelerator. The slope parameter, the ratio of the real to the imaginary part of the forward amplitude and the cross section in the diffraction cone were measured. (auth)

Strong (Meson-Induced)

50065 (JINR–P-1-5874) POSSIBLE EXISTENCE OF THE $\pi^-\gamma$ RESONANCE AT 270 MeV. Budagov, Yu. A.; Vinogradov, V. B.; Volodko, A. G.; Dzhelepov, V. P.; Kladnitskii, V. S.; Koutsidi, N. K.; Lomakin, Yu. F.; Maksimenko, V. A.; Martinska, G.; Flyagin, V. B.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

An experimental indication was obtained for the possible existence of a new resonance: in the $\pi^-\gamma$ effective mass spectrum produced in the reaction $\pi^- p \rightarrow \pi^- p + (2,3)\gamma$ at $P_{\pi^-} = 5$ GeV/c a narrow peak was observed at $M_{\pi^-\gamma} = (270 \pm 5)$ MeV with the excess by (5.2 ± 0.4) standard deviations over the background curve. The experiment was performed using the one-meter propane bubble chamber of the Joint Institute for Nuclear Research. (auth)

50066 (JINR–P-2-5924) CROSS SECTIONS OF THE PION–NUCLEON INTERACTIONS. Barashenkov, V. S.; Okhlopkova, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1971. 30p. (In Russian). Dep. NTIS (U. S. Sales Only).

The curves of the energy dependences of the pion–proton interaction cross sections, constructed over the known experimental data, are given. (auth)

50067 (UCLA-34-P-106-58) ANNUAL PROGRESS REPORT, JUNE 1, 1970–MAY 31, 1971. (California Univ., Los Angeles. Dept. of Physics). 30 Jun 1971. Contract AT(04-3)-34. 23p. Dep. NTIS.

XUM

Experimental research on strong interactions up to 1 GeV is summarized. A brief review of the goals and status of this program is given. A list of publications is included. (J.F.P.)

50068 BEHAVIOR OF THE AVERAGE TRANSVERSE MOMENTUM OF SECONDARIES IN π^-p HIGH-ENERGY INTERACTIONS. Balea, E.; Balea, O.; Besliu, C.; (and others) (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 2, 189-95(1971).

The behavior of the average transverse momentum of various secondary particles in 7.5 and 20 GeV/c π^-p interactions with strange particle production is analyzed. The results are compared with the phase space predictions. (auth)

50069 EXPERIMENTAL EVIDENCE FOR A HIGH-MASS VECTOR MESON. Benvenuti, A.; Cline, D.; Rutz, R.; Reeder, D. D.; Scherer, V. R. (Univ. of Wisconsin, Madison). Phys. Rev. Lett.; 27: No. 5, 283-6(2 Aug 1971).

The cross section for the reaction $\bar{p}p \rightarrow K_S^0K_L^0$ from 100 to 800 MeV/c was measured. A significant enhancement in the cross section is observed at a mean momentum of 600 MeV/c. A Legendre-polynomial analysis of the angular distributions also shows an enhancement in the A_2 coefficient in the same momentum range. A plausible explanation of the data indicates a new meson state $\rho(1970)$ with a mass M = 1968 MeV, width Γ = 35 MeV, and $J^{PC} = 1^{--}$. (auth)

50070 STUDY OF THE REACTION $\pi^-p \rightarrow \pi^+\Delta(1236)^-$ IN THE BACKWARD DIRECTION AT 2.15 TO 6 GeV/c. Rice, J. E. (Univ. of Michigan, Ann Arbor); Anthony, R. W.; Coffin, C. T.; (and others). Phys. Rev. Lett.; 27: No. 10, 687-9(6 Sep 1971).

Data on the differential cross section for the reaction $\pi^-p \rightarrow \pi^+\Delta(1236)^-$ are presented for π^+ scattered backward near 180°, $-0.002 > u - u_{max} \gtrsim -0.09$ (GeV/c)^2, with incident π^- beam momenta between 2.15 and 6 GeV/c. The differential cross section exhibits a sharp backward dip, which appears to persist over this range of incident momenta. (auth)

50071 PION PRODUCTION MECHANISM IN HIGH MULTIPLICITY π^+p INTERACTIONS AT 8 GeV/c. Coghen, T. (Inst. of Nuclear Physics, Krakow); Czyzewski, O.; Eskreys, A.; (and others). Nucl. Phys.; B32: No. 1, 189-204(1971).

The mechanism of pion production in eight-prong π^+p reactions is discussed in terms of two models: (i) the "fireball" model and (ii) multiperipheral CLA model. Both models give adequate description of the general features of the experimental data, however, they fail in the prediction of fine details of the processes. (auth)

50072 DCS FOR π^-p ELASTIC SCATTERING FROM 1.2 TO 3.0 GeV/c AND PHASE SHIFT ANALYSIS. Alpin, P. S. (Univ. of Bristol, Eng.); Cowan, I. M.; Gibson, W. M.; (and others). Nucl. Phys.; B32: No. 1, 253-84(1971).

Differential cross sections were measured for π^-p elastic scattering at laboratory momenta in the range 1.2 to 3.0 GeV/c for the c.m. range $0.97 > \cos\theta^* > -0.98$. The corresponding mass range is 1.78 to 2.56 GeV/c^2. The data was obtained from a counter experiment in which the scattered pions and protons were detected in coincidence by arrays of scintillation counters. The results are discussed and compared with the CERN phase-shift analyses. The results of a further restricted phase-shift analysis are presented which give support to the evidence for the $P_{13}(1860)$ resonance and suggest a possible F_{17}/G_{17} doublet with a mass near 2000 MeV. (auth)

50073 PRODUCTION OF K^+K^- AND $p\bar{p}$ PAIRS IN FOUR-BODY REACTIONS AT 13.1 GeV/c. Gaidos, J. A.; Mulera, T. A.; Ezell, C. R.; Lamsa, J. W.; Willmann, R. B. (Purdue Univ., Lafayette, Ind.). Nucl. Phys.; B32: No. 1, 10-18(1971).

Data in the channels $\pi^+p \rightarrow \pi^+p\,K^+K^-$ and $\pi^+p \rightarrow \pi^+p\bar{p}p$ at 13.1 GeV/c are presented; the Δ^{++} K^+K^- and p $K^+K^*(890)$ subsamples are discussed in terms of a double-Regge model. No resonance structure at $M(p\bar{p}p) = 3.755$ GeV is observed. (auth)

50074 FOUR-MOMENTUM TRANSFER DISTRIBUTIONS OF NUCLEONS IN π^-p INTERACTIONS AT 16 GeV/c. Honecker, R. (Technische Hochschule, Aachen); Rumpf, K.; Schmitz, P.; (and others). Nucl. Phys.; B32: No. 1, 141-8(1971).

Distributions of four-momentum transfer from target proton to nucleon, $d\sigma/dt$, for 16 GeV/c π^-p reactions giving in the final state 2 to 8 pions, are analyzed in terms of the F(t) function, which gives the average t-dependence of the matrix element squared for the reaction in question. It is shown that this function has a shape similar to the squared pion propagator for the reactions containing 3 to 8 pions in the final state. The data for 8 GeV/c π^+p reactions give results qualitatively similar to those for 16 GeV/c π^-p. (auth)

50075 LONGITUDINAL MOMENTUM DISTRIBUTIONS OF π^- MESONS PRODUCED IN 12.7 GeV/c K^+p AND 7 GeV/c π^+p INTERACTIONS. Stone, S. L.; Cohen, D.; Farber, M.; (and others) (Univ. of Rochester, N. Y.). Nucl. Phys.; B32: No. 1, 19-28(1971).

The center of mass longitudinal momentum distributions of π^- mesons produced in K^+p interactions at 12.7 GeV/c and in π^+p interactions at 7 GeV/c exhibit an asymmetry similar to that observed, for example, in single particle production in 25 GeV/c π^-p interactions. This asymmetry is discussed in terms of quark structure of hadrons and other dynamical models. (auth)

50076 COHERENT PRODUCTION OF 3 CHARGED PIONS ANALYSED BY MEANS OF THE LONGITUDINAL PHASE SPACE PLOT. Arnold, R. (Laboratoire de Physique Corpusculaire, Strasbourg); Escoubes, B.; Kurtz, N.; (and others). Phys. Lett.; 36B: No. 3, 261-5(6 Sep 1971).

A study of $\pi^+\pi^+\pi^-$ system produced by 11.7 GeV/c π^+-nuclei interactions by means of longitudinal phase space analysis is presented. This method has allowed a selection of events produced coherently on nuclei with a reduced background. (auth)

50077 A_2^- PRODUCTION IN THE CHANNEL $\pi^+\pi^-\pi^-$ NEAR THRESHOLD. Binne, D. M. (Imperial Coll. of Science and Tech., London); Camilleri, L.; Duane, A.; (and others). Phys. Lett.; 36B: No. 3, 257-60(6 Sep 1971).

The mass spectrum of the A_2 meson was studied in the reaction $\pi^- + p \rightarrow A_2^- + p$, $A_2^- \rightarrow \pi^+\pi^-\pi^-$ near threshold over a range of four-momentum transfer from -0.2 to -0.9 (GeV/c)^2. No significant evidence for any structure within the resonance was found. (auth)

Particle Interactions and Properties (Theoretical)

General

50078 (AD-712708) RESEARCH ON THEORETICAL HIGH-ENERGY PHYSICS AND QUANTUM THEORY OF ELEMENTARY PARTICLES. Final Scientific Report. Eden, Richard J. (Cambridge Univ. (England). Dept. of Physics). Jul 1970. 8p. (AFOSR-70-2459-TR). NTIS.

Theoretical research was carried out in the following main areas in the theory of elementary particles: strong interactions, especially in relation to self-consistency by the phase contour method relating high energy and low energy behavior of collision amplitudes; generalization of the Veneziano model, especially in relation to the inclusion of realistic particles with nonzero spin; group theory and symmetries, especially in relation to kinematic singularities in amplitudes due to nonzero spin of colliding particles; S matrix theory; weak interactions. (auth)

50079 (COO-1764-121) ASYMPTOTIC BEHAVIOR AND THE POSSIBILITY OF DUALITY WITHOUT GHOSTS IN FEYNMAN DIAGRAM MODELS. Coon, D. D. (Minnesota Univ., Minneapolis. School of Physics and Astronomy). [1970]. Contract AT(11-1)-1764. 23p. Dep. NTIS.

Elastic scattering of two spinless particles with equal or unequal masses is considered in Feynman diagram models of the Van Hove type with arbitrary spectra of masses, spins and coupling constants including infinitely large masses and spins. It is shown that if the amplitude defined by analytic continuation of the sum of all lowest-order diagrams with s-channel poles has no unphysical or u-channel singularities, then for fixed t this amplitude is not bounded by any power of s as $|s| \rightarrow \infty$ in any infinitely multiply connected domain which excludes only neighborhoods of the poles. As a consequence, models of the Van Hove type cannot exhibit duality. The result is independent of the order of summation of diagrams. It depends crucially on the requirement that coupling constants be real. (auth)

50080 (IFVE-STF-70-62) MODEL OF MULTI-PARTICLE PRODUCTION. Savrin, V. I.; Turin, N. E.; Khrustalev, O. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1970. 19p. (In Russian). Dep. NTIS (U. S. Sales Only).

The model of the production of statistically independent particles is considered. Expression for the average multiplicity and final momentum distribution of secondary particles were obtained. Their dependence on incident particles is under discussion. A connection is found between the average number of particles produced and the scattering of an inelastic channel to the imaginary part of the scattering amplitude. (auth)

XUM

50081 (ORO–3992-53) FOURIER TRANSFORMS IN THE NONPOLYNOMIAL HARMONIC OSCILLATOR MODEL. Fels, Stephen B. (California Univ., Los Angeles. Dept. of Physics. Texas Univ., Austin. Center for Particle Theory). Apr 1971. 20p. (CPT–103; AEC–53). Dep. NTIS.

Problems associated with the Lee–Zumino approach to nonpolynomial interactions are shown to exist even after employing their special method for calculating the Fourier transforms of Green's functions. (auth)

50082 INELASTIC ONE-CHANNEL SCATTERING PROBLEM WITH PURE ABSORPTION. Stihi, M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 1, 31-40(1971).

Use of the inelasticity parameter η_l into the partial wave one-channel scattering integral equations leads to difficulties whenever η_l tends to zero (pure absorption) — at infinite energy or at some finite energies above the inelastic threshold — which can be overcome in the frame of the relativistic f/f method. (auth)

50083 SCATTERING LENGTHS USING THE THEORY OF DIRAC AND THAT OF SCHROEDINGER. Ronveaux, Andre (Univ., Namur, Belgium). Compt. Rend., Ser. B; 272: No. 22, 1229-31(2 Jun 1971). (In French).

Equations for scattering lengths are established using the theory of Dirac; they are compared with the corresponding equations obtained from Schroedinger theory. Supplementary terms in $1/c^2$ allow the Dirac phase shift behavior at low energy to be predicted. (France)

50084 PROGRAM TO CALCULATE COMPLEX PHASE SHIFTS AND MIXING PARAMETERS OF ELASTIC SCATTERING OF SPIN ½ PARTICLES OF SPIN ½ TARGETS. Kankowsky, R.; Fick, D. (Univ., Erlangen, Ger.). Comput. Phys. Commun.: 2: No. 4, 223-30(May-Jun 1971).

The computer program PHASESHIFT ANALYSIS is described for calculating complex phase shifts and mixing parameters for spin-½ particle elastic scattering on spin-½ particles. The program is written in FORTRAN IV and is designed for the CDC 3300. (J.F.P.)

50085 EVALUATION OF THE VOLUME OF THE PHASE SPACE OF N PARTICLES. Kajantie, K.; Karimaeki, V. (Univ. of Helsinki). Comput. Phys. Commun.: 2: No. 4, 207-13(May-Jun 1971).

The computer program RN is described for the evaluation of the volume of the phase space of N particles in high-energy particle production reactions. The program is written in FORTRAN IV for the Burroughs 6500. (J.F.P.)

50086 NEW METHOD FOR TREATING SYSTEMS CONTAINING ELEMENTARY COMPOSITE PARTICLES (NONRELATIVISTIC THEORY). Stolt, Robert H.; Brittin, Wesley E. (Univ. of Colorado, Boulder). Phys. Rev. Lett.; 27: No. 9, 616-19(30 Aug 1971).

Systems containing bound and free particles are described by simple Bose or Fermi fields, one representing bound particles and others representing free particles. The lack of proper symmetry for states corresponding to given numbers of bound and free particles is corrected by drawing a correspondence (partial isometry) between proper physical states and these. When transformed to the new basis, the Hamiltonian is found to contain non-particle-conserving terms and exchange terms. (auth)

50087 PARTICLE PHYSICS: THE HIGH-ENERGY FRONTIER. Livingston, M. Stanley. McGraw-Hill Paperbacks in Physics. New York; McGraw-Hill Book Company (1968). 238p.

An introductory survey of the field of particle physics is presented. The topics covered are the nuclear atom, quanta, and waves in atoms, elementary particles, conservation laws, masses of the observable particles, parity, charge independence and isotopic spin, strangeness, resonances, and the basic symmetries of nature. (J.F.P.)

50088 DUAL-AMPLITUDE ANALYSIS OF TWO-PARTICLE PRODUCTIONS. Jen, Chian-li; Kang, Kyungsik; Shen, Pu; Tan, Chung-i (Brown Univ., Providence). Phys. Rev. Lett.; 27: No. 7, 458-61(16 Aug 1971).

The results on the two-particle production cross section for the process $a + b \to x_1 + x_2 +$ anything at high energy predicted by the dual-resonance model are presented. The distribution functions for all the kinematic regions are shown to have the desired variable dependence and properties. In particular, it is found that the two-particle "correlation length" is of the order of 1 GeV^{-1}. (auth)

Electromagnetic

Refer also to abstracts 49004 and 50169.

50089 (CONF-690732, pp 14.1-12) SCATTERING OF SPIN-½ PARTICLES FROM ONE-DIMENSIONAL ELECTROSTATIC POTENTIALS. Feder, R. (Cape Town Univ. (South Africa). Dept. of Physics).

From fourth seminar on theoretical physics; Johannesburg, South Africa (7 Jul 1969).

By means of a covariant formalism for the description of spin the scattering of polarized spin one-half particles from electrostatic potentials that depend on only one space co-ordinate is investigated. The scattered intensity is calculated as a function of a fundamental solution of two ordinary linear differential equations and it is found that it is independent of the polarization of the initial beam. The polarization vector is rotated about an axis normal to the plane of incidence through an angle that depends on the energy and the angle of incidence of the initial beam. (auth)

50090 (JINR–P-2-5901) ELECTROMAGNETIC FORM FACTORS OF A PROTON. Bilenkaya, S. I.; Kazarinov, Yu. M.; Lapidus, L. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

For the electromagnetic form factors of protons with the help of all the known data on elastic e–p and ~–p scattering in the interval $0.012 \le t^2 \le 25$ $(GeV/c)^2$ a statistically satisfactory description of proton vector form factors was found. The χ^2 minimum for cross sections with radiative corrections taken into account was found under various suppositions for the q^2 dependence of form factors. When q^2 dependence was supposed the values of fitted parameters a_1 and b_1 were found. The $\chi^2 = 416$ when $\bar{\chi}^2 = 339$ with these values of parameters given conditions are valid. Then $G_E(q^2) \cong (1 - \alpha_2 q^2)^{-1}(\Lambda + \alpha_3 q^2)^{-1}$ and $G \sim q^{-4}$ at high q^2 values. The relative errors for G_E are larger than for G_M. The new experiments with polarized leptons and polarized proton targets are desirable for better determination of G_E. As is seen when scaling-law parameters a_1 and b_1 are not assigned, b_2 and b_2 are different outside of two standard. When a relation was assumed for G_M, $C = (7{,}7 \pm 1.8) \cdot 10^{-4}$. With the two pole description of proton form factors based on the whole amount of e–p data a comparison is made with μ–p data. As in the previous work e–p and μ–p data are renormalization factors practically depending not on parametrization of form factors. No deviation from μ–e universality was found but μ–p data were compared with the whole amount of e–p data. Both data on e–p and μ–p scattering are represented with $\chi^{22} = 479$ when $\bar{\chi}^2 = 401$. Also the Frampton[2] parametrization was used for proton form factors. The values of $\alpha \cdot (0)$ and $\alpha'(0)$ for ρ-trajectory are different from "standard" values. The value of the τ_μ is close to the Frampton one which was obtained from the G_M data. The deviation from one proton exchange approximation in the Rosenbluth formula was allowed. (auth)

50091 (JINR–P2-5941) ATOMIC DECAYS OF ELEMENTARY PARTICLES. Nemenov, L. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

The decays of elementary particles, accompanied by the atomic system emission, are considered. The relative probability of the $\pi^0 \to \gamma + (e^+e^-)$ – atom, $\eta^0 \to \gamma + (e^+e^-)$ – atom, $\eta^0 \to \gamma + (\mu^+\mu^-)$ – atom decays is calculated. The dependence of the relative probability to observe positrons from the $\pi^0 \to \gamma + (e^+e^-)$ decay on the neutral pion life-time is pointed out. (auth)

50092 (ORO–3992-33) t-CHANNEL TRANSFORMATION MATRICES FOR HELICITY AND INVARIANT AMPLITUDES FOR $\gamma + N \to 0^- + B$. Clark, Robert Beck; Manny, Ben L.; Parsons, Ronald G. (Texas Univ., Austin. Center for Particle Theory). Revised Feb 1971. 75p. (CPT–84(Rev.); AEC–33). Dep. NTIS.

The algebraic transformation matrices, valid for all s and t, connecting the t-channel helicity amplitudes to a corresponding set of gauge invariant amplitudes are calculated for the photoproduction processes $\gamma + N \to 0^- + B(J^P = \frac{1}{2}^+, \frac{1}{2}^-, \frac{3}{2}^+, \frac{3}{2}^-)$. (auth)

50093 (ORO–3992-37) s-CHANNEL TRANSFORMATION MATRICES FOR HELICITY AND INVARIANT AMPLITUDES FOR $\gamma + N \to 0^- + B$. Parsons, Ronald G. (Texas Univ., Austin. Center for Particle Theory). Jan 1971. 69p. (CPT–88; AEC–37). Dep. NTIS.

The algebraic transformation matrices, valid for all s and t, connecting the s-channel helicity amplitudes to a corresponding set of gauge invariant covariant amplitudes are calculated for the

photoproduction processes $\gamma + N \rightarrow 0^- + B(J^P = 1/2^+, 1/2^-, 3/2^+, 3/2^-)$. (auth)

50094 (ORO–3992-62) HIGH-INTENSITY COMPTON SCATTERING AND THE ORIGIN OF THE WAVE-LENGTH SHIFT WITHIN THE FRAMEWORK OF A SEMI-CLASSICAL TREATMENT. Richard, J. L. (Texas Univ., Austin. Center for Particle Theory). 23 Jun 1971. 17p. (CPT–112; AEC–62). Dep. NTIS.

Using group theoretical arguments, it is shown that the nonlinear wavelength shift predicted previously in high-intensity Compton scattering appears only if the electron is considered as being totally contained in the laser beam. (auth)

50095 MULTIPLE SCATTERING OF FAST ELECTRONS. Gusev, E. A.; Evdokimov, O. B. (Tomsk State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 7, 155-7(1970). (In Russian).

The influence of various separate collisions on the angular distribution of fast electrons subjected to multiple collisions was studied in order to determine the effects of electron interactions with nuclei and as pertinent data for electron microscopy. (R.V.J.)

50096 ANALYTICAL PROPERTIES OF THE AMPLITUDE OF THE COMPTON EFFECT ON THE DEUTERON. Maksimenko, N. V. (Inst. of Physics, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 4, 91-100(1970). (In Russian).

The characteristics of the amplitude for the Compton effect on deuterons were studied, and explicit expressions obtained for the spectral functions for each of 12 independent amplitudes, corresponding to a fourth-order diagram. (tr-auth)

50097 DEEP INELASTIC SCATTERING OF ELECTRONS ON A PHOTON TARGET. Brodsky, S. J. (Stanford Linear Accelerator Center, Calif.); Kinoshita, Toichiro; Terazawa, Hidezumi. Phys. Rev. Lett.; 27: No. 5, 280-3(2 Aug 1971).

One of the processes which may be observed in e^+e^- colliding-beam experiments is the deep inelastic electron-photon scattering. The feasibility of such an experiment assuming an appropriate scaling limit is examined. (auth)

50098 PARTONS AND DEEP-INELASTIC ELECTRON SCATTERING. Wilson, Kenneth G. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett.; 27: No. 10, 690-2(6 Sep 1971).

A new parton model is defined. Two predictions are obtained for deep-inelastic e–p scattering: at an invariant momentum transfer $-Q^2$ of 1 GeV^2, at least half the final states will contain a K meson; for a value of $-Q^2$ somewhere between 8 and 30 GeV^2, the Bjorken scaling prediction will be violated and a large fraction of the final states will contain an antibaryon. (auth)

50099 CONSIDERATIONS ON MEASURING $\gamma + \gamma \rightarrow \pi^+ + \pi^-$ WITH COLLIDING BEAMS. Cheng, H. (Massachusetts Inst. of Tech., Cambridge. Deutsches Elektronen-Synchrotron, Hamburg); Wu, T. T. Phys. Lett.; 36B: No. 3, 241-5(6 Sep 1971).

Differential cross sections for pionization in electron–electron (or electron–positron) colliding beams are largest when the produced pions have nearly equal but opposite transverse momenta. Measurement in this case can determine the two amplitudes and relative phase for $\gamma + \gamma \rightarrow \pi^+ + \pi^-$. (auth)

50100 CONSTRUCTION OF PION PHOTOPRODUCTION AMPLITUDES FROM EXPERIMENTAL DATA. 2. PHASE OF THE FORWARD $\gamma p \rightarrow \pi^+ n$ AMPLITUDE. Alvarez-Estrada, R. F. (CERN, Geneva); Sanchez-Gomez, J. L. Nucl. Phys.; B32: No. 1, 214-20(1971).

A formalism for constructing the pion photoproduction amplitudes from experimental data introduced in a previous paper is extended to derive a dispersion relation for the phase of the forward pion photoproduction amplitude in terms of the measurable amplitude modulus. This dispersion relation is used to compute the phase of the forward $\gamma p \rightarrow \pi^+ n$ amplitude. (auth)

50101 SCALING, FIXED POLES, AND DUALITY OF ELECTROMAGNETIC CURRENTS IN THE DYNAMICAL RESONANCE MODEL. Manassah, J. T.; Matsuda, S. (Inst. for Advanced Study, Princeton, N. J.). Phys. Lett.; 36B: No. 3, 229-34(6 Sep 1971).

A dynamical resonance model with electromagnetic interaction is constructed. The theory is gauge invariant, dual and factorizable. The elastic form factor has an infinite series of poles. The structure functions scale and satisfy dispersion relation. Current algebra sum rules hold with a fixed pole. (auth)

50102 PHOTONS CREATION BY AN EXTERNAL FIELD. Galtsov, D.; Skobelev (Moscow State Univ.). Phys. Lett.; 36B: No. 3, 238-40(6 Sep 1971).

Nonlinear photons creation by a variable external electromagnetic field is considered in low-energy approximation. General formulas for one, two and three-photons creation are obtained and some applications are briefly discussed. (auth)

50103 ANNIHILATION CHANNEL IN THE PHOTOPRODUCTION OF VECTOR MESONS. Zotov, N. P. Tr. Univ. Druzhby Nar., Fiz.; 44: 144-50(1969). (In Russian).

The annihilation amplitude of the vector meson photoproduction is investigated. An invariant form of the protoproduction amplitude is introduced. An expression for this amplitude in the center-of-mass system is found, and the decomposition in partial waves is carried out. (auth)

50104 OCTET DOMINANCE ON THE LIGHT CONE. De Alwis, S. P. (Cambridge Univ., Eng.). Phys. Lett.; 36B: No. 2, 106-9(23 Aug 1971).

The realization that the deep inelastic region in momentum space for the electro and neutrino production is equivalent to the region near the light cone in x-space for the commutator of two currents is considered. The light-cone expansion for the commutator of two octet (weak or electromagnetic) currents is constructed under given assumptions. (J.F.P.)

50105 POSSIBLE METHOD OF MEASURING THE ELECTROMAGNETIC FORM FACTOR OF THE NEUTRINO. Andryushin, V. I.; Bilen'kii, S. M.; Gershtein, S. S. (Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.); 13: No. 10, 409-12(20 May 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 13: No. 10, 573-6(20 May 1971).

A method for obtaining complete information on the electromagnetic form factor of the neutrino, including the dependence of the form factor on the square of the momentum transfer is studied. This method is based on a comparison of the cross section of the process due to the electromagnetic interaction of the neutrino with the nucleus, with the cross section of the analogous process due to the electron. The cross section for the excitation of the giant resonance on tantalum-181 by 30- and 100-MeV neutrinos, and the cross section for the fission of bismuth-209 by neutrinos at about 250 MeV are calculated from previous data. (J.F.P.)

50106 SPEED OF GAMMA RAYS EMITTED BY HIGH SPEED PARTICLES. Kantor, Wallace. Spectrosc. Lett.; 4: No. 7, 245-53(Jul 1971).

Experiments alleged to confirm the absolute speed of light on the emission of gamma rays by high speed particles are shown to be inconclusive. These experiments were interpreted quantitatively on the basis of an "extinction" hypothesis formulated previously for which there is no experimental confirmation or denial. Rather than confirming the absolute speed of light, these null-result experiments can also be regarded as merely showing the obliteration of the relative speed of light as it propagates through various media. (auth)

Weak

50107 (JINR-E2-5881) ON $K^+ \rightarrow \mu^+ \nu_\mu \nu_\mu \bar{\nu}_\mu$ DECAY. Bardin, D. Yu.; Bilen'kii, S. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 10p. Dep. NTIS (U. S. Sales Only).

The decay $K^+ \rightarrow \mu^+ \nu_\mu \nu_\mu \bar{\nu}_\mu$ is considered under different assumptions on the form of the $\nu_\mu - \nu_\mu$ interaction Hamiltonian. The μ^+-meson spectrum and polarization as well as the total decay probability are calculated. An experimental study of this process would allow information on $\nu_\mu - \nu_\mu$ interaction to be obtained. (auth)

50108 (JINR-P-2-5904) THE $\mu^+ \rightarrow e^+ \nu_e \bar{\nu}_\mu e^+ e^-$ DECAY. Bardin, D. Yu.; Istatkov, Ts. G.; Micelmacher, G. V. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1971. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

A detailed calculation of the $\mu^+ \rightarrow e^+ \nu_e \bar{\nu}_\mu e^+ e^-$ process is made in the lowest order over the weak and electromagnetic interactions. The obtained results are compared with experiment. (auth)

50109 (ORO–3992-29) LEPTONIC RESONANCES. Sudarshan, E. C. G. (Texas Univ., Austin. Center for Particle Theory). [1970]. 4p. (CPT–80; AEC–29). Dep. NTIS.

Leptonic resonances are predicted in the GeV region on the

basis of finite quantum field theory with an indefinite metric. (auth)

50110 (ORO-3992-50) BEYOND QUADRATIC SMOOTHNESS IN HARD MESON ANALYSIS OF K_{l3} DECAY. Acharya, R. (Texas Univ., Austin. Center for Particle Theory). Apr 1971. 13p. (CPT-100; AEC-50). Dep. NTIS.

The question of mutual consistency between the conventional hard meson analysis of K_{l3} decay and the Dashen-Weinstein theorem for this decay is investigated. It is shown without reference to the nature of SU(3) ⊗ SU(3) breakdown that the quadratic smoothness postulate is not consistent with the Dashen-Weinstein result. It is then demonstrated that the retention of quartic terms in the power series expansion of the proper $\pi K \kappa$ vertex within the framework of (3,3*) + (3*,3) breaking, restores the consistency and leads to the kappa mass of the right order of magnitude. (auth)

50111 (ORO-3992-51) HIGHER ORDER TERMS IN THE V-A THEORY OF THE WEAK INTERACTIONS AND LEPTONIC SCATTERING PROCESSES AT HIGH ENERGIES. Maiella, G.; Lopez-Cepero, A. B. (Texas Univ., Austin. Center for Particle Theory). Apr 1971. Contract AT(40-1)-3992. 32p. (CPT-101; AEC-51). Dep. NTIS.

An attempt is made to evaluate higher-order corrections for the V-A theory of the weak interactions. Instead of the customary cut-off method, a perturbative expansion at the second order in G_μ is employed. Then the second-order Feynman diagrams are computed introducing indetermined subtraction constants to make the matrix elements finite. This analysis is applied to the leptonic scattering process at high energies. It is shown that their cross sections can be parameterized in terms of one unknown constant b_l, under the assumption that $b_l \gg 1$. Using a previous rough evaluation of b_l it is predicted that the second-order corrections to the first-order leptonic processes and the cross sections of the second-order processes can be measured experimentally. Finally, the consequences of the lack of the diagonal interaction in the V-A leptonic Lagrangian are discussed. (auth)

50112 PHOTON SPECTRUM IN RADIATIVE Ω^--DECAYS. Burlacu, L. (Univ., Bucharest); Raszillier, I.; Stamatescu, I. O. Rev. Roum. Phys.; 16: No. 1, 63-72(1971).

The photonic spectrum in the three radiative decays of Ω^-: $\to K^-\Lambda\gamma$, $\pi^-\Xi^0\gamma$, $\pi^0\Xi^-\gamma$ is computed. In the first two the (relative) decay rates for both pure parity-conserving and parity-violating nonradiative vertices are insensitive to the values of electromagnetic multipoles, at least for not too high frequencies, where one expects the Born terms to dominate. In the third decay, on the contrary, they depend very much on the Ω^- magnetic moment, for which (theoretical) predictions allow a wide range of values. (auth)

50113 FINAL-STATE INTERACTIONS IN NONLEPTONIC HYPERON DECAYS. Reid, H. H.; Trofimenkoff, N. N. (Univ. of Calgary, Can.). Phys. Rev. Lett.; 27: No. 5, 274-6(2 Aug 1971).

The effects of final-state interactions on nonleptonic hyperon decay amplitudes are evaluated within the current-algebra framework of partially conserved axial-vector currents. Good agreement with experimental amplitudes is obtained for both S- and P-wave decays. (auth)

Strong (General)

50114 (COO-2009-23) ON THE EQUIVALENCE OF REGGE AND OPTICAL MODELS. Hendry, Archibald W. (Indiana Univ., Bloomington. Dept. of Physics). [1971]. Contract AT(11-1)-2009B. 14p. Dep. NTIS.

It is suggested that the Regge model is equivalent to an optical model. It is shown that the effect of combining a Regge pole and destructive cut is to imitate a direct channel Regge pole; the rotating Regge part is "dual" to scattering from the edge of the interaction region. Schmid loops are interpreted: Regge energy dependence is related to the energy independence of the interaction radius. (auth)

50115 (JINR-E2-5898) ON ESTIMATE OF THE AVERAGE MULTIPLICITY ASYMPTOTIC BEHAVIOUR AND DIFFRACTION MECHANISM OF PARTICLE INTERACTIONS AT HIGH ENERGIES. Kuleshov, S. P.; Matveev, V. A.; Sisakyan, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 14p. Dep. NTIS (U. S. Sales Only).

A definite simple relation, which connects the average multiplicity asymptotic behavior with the total cross section and the elastic diffraction slope parameter, is given. The picture of high-energy diffraction processes which is based on the coherent state model as well as on the straight-line path approximation method in quantum field theory models is assumed. (auth)

50116 (JINR-E2-5962) AUTOMODALITY HYPOTHESIS AND THE ASYMPTOTIC BEHAVIOUR OF STRONG, ELECTROMAGNETIC, AND WEAK INTERACTIONS AT HIGH ENERGIES. Matveev, V. A.; Muradyan, R. M.; Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 15p. Dep. NTIS (U. S. Sales Only).

The hypothesis of automodality or scale invariance is used to predict the asymptotic behavior of strong, electromagnetic and weak interactions at high energies. (auth)

50117 (JINR-P-2-5871) SYMMETRICAL THREE-TRIPLET HADRON MODEL WITHOUT QUARKS. Govorkov, A. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

An attempt is made to connect the fact of the absence of quarks in a free state with the presence of the communication symmetry in the framework of the triplet hadron model. (auth)

50118 (SU-1206-254) MULTIPERIPHERAL MODELS WITH CHARGED PARTICLES. Amann, R. F. (Syracuse Univ., N. Y. Dept. of Physics). Jun 1971. 38p. (NYO-3399-254). Dep. NTIS.

Techniques are developed to allow the inclusion of many particles with differing quantum numbers in the multiperipheral chain. Within the Chew-Pignotti multi-Regge model these techniques are applied to allow the inclusion of charge in the model. The proposed models for the isospin structure of the chain, repeated isovector exchange and alternating isoscalar-isovector exchange are discussed; secondary intercepts, charged particle multiplicities, rapidity distributions for charged particles and cross sections for the production of charged prongs are calculated. One immediate result is that an isovector chain predicts that an incoming proton will emerge as a neutron two-thirds of the time (compared to the observed one-third); any realistic model must include isoscalar exchanges in the chain. It is suggested that, if the Pomeranchukon is generated by a simple subset of the available exchanges, then inclusive experiments should spotlight those Regge poles generated simultaneously with it. The utilization of charge correlations to explore this possibility is discussed. (auth)

50119 THEORETICAL MODELS OF DIFFRACTION SCATTERING. Zachariasen, F. (CERN, Geneva). Phys. Rep.: 2C: No. 1, 1-75(Jul 1971).

Theoretical information on high-energy diffraction scattering is reviewed. After a brief survey of the experimental situation, first model-independent constraints on diffraction imposed by generally accepted principles such as analyticity, crossing and unitarity are discussed. Then a description of the various models which are popular at present, and their specific consequences for high-energy diffractive processes are given. It is concluded that none of these models is completely satisfactory from both experimental and theoretical points of view. (auth)

50120 s⇌u SYMMETRY OF s-CHANNEL HELICITY AMPLITUDES. Shtokhamer, R.; Berlad, G.; Eilam, G. (Technion-Israel Inst. of Tech., Haifa). Phys. Rev. Lett.; 27: No. 9, 625-7 (30 Aug 1971).

The s⇌u symmetry of s-channel helicity amplitudes is investigated without the exchange mechanism being specified. Conclusions are drawn concerning the possibility of phase assignment to scattering amplitudes at high energy. Difficulties are found in absorption models with $J_{\Delta\lambda} s^\alpha$ behavior. (auth)

50121 MULTIPERIPHERAL-MODEL PREDICTIONS CONCERNING PION PRODUCTION IN HIGH-ENERGY COLLISIONS. Webber, Bryan R. (Univ. of California, Berkeley). Phys. Rev. Lett.; 27: No. 7, 448-51(16 Aug 1971).

The pion-exchange multiperipheral model is used to predict the amount and spectrum of pion production at small c.m. momenta in high-energy collisions. The transverse momentum distribution, which agrees with the present experimental data, is predicted to remain unchanged at all higher energies; but the number of pions produced per unit volume of phase space, which is related to the average multiplicity, is predicted to decrease. (auth)

50122 PHENOMENOLOGY OF TOTAL CROSS SECTIONS AND FORWARD SCATTERING AT HIGH ENERGY. Barger, V. (Univ. of Wisconsin, Madison); Phillips, R. J. N. Nucl. Phys.; B32: No. 1, 93-118(1971).

XUM

Theoretical models of total cross sections are reviewed, beginning with the simple Regge pole model. A variety of possibilities for asymptotic growth with energy which are compatible with experimental data from the Serpukhov accelerator are considered. Forward elastic and inelastic scattering measurements that could help differentiate among the various models are discussed. (auth)

50123 POISSON DISTRIBUTIONS, THE ELASTIC CROSS SECTION, ANALYTICITY, AND UNITARITY. Kaiser, G. D. (Univ. of Durham, Eng.). Nucl. Phys.; B32: No. 1, 238-52 (1971).

The use of the Poisson distribution in strong interaction physics is discussed with particular reference to the role of the elastic cross section. It is shown that the conjecture that charged pairs follow a Poisson distribution, with the elastic cross section included, is consistent with data at both accelerator and cosmic-ray energies. The requirements of analyticity and unitarity lead to an upper bound on the mean multiplicity of charged pairs $\bar{n}$ such that $\exp(2\bar{n}) \leq \pi s^2 \sigma(\text{tot}) \{\ln(s/\sigma(\text{el}))\}^2/m^2|F(s,0)|^2$. If it is assumed that $\sigma(\text{tot})$ is asymptotically constant, this bound is saturated. It is concluded that the available data do not discount the possibility that statistical models are able to predict elastic cross sections with no modification needed to take account of diffractive effects. (auth)

Strong (Baryon No. = 0)

Refer also to abstract 50055.

50124 (IS-T-480) ANGULAR CORRELATION THEORY IN HIGH ENERGY PHYSICS. Schmidt, Christopher Karl (Ames Lab., Iowa). Aug 1971. Contract W-7405-eng-82. 73p. Dep. NTIS.

Thesis.

The angular distribution for double resonance production is derived by separating the S-matrix into individually Lorentz invariant production and decay factors. Each factor is treated separately using helicity states. Direct- and crossed-channel amplitudes are used to obtain two expressions for the direct-channel angular distribution. Kinematic constraints, parity predictions and expectation functions for linear combinations of production density matrix elements are obtained using moment analysis. A Regge-pole model for the production reaction is presented. The results are applied to the reaction $\bar{p}p \rightarrow \bar{\Delta}\Delta \rightarrow \bar{p}\pi^- p\pi^+$. (auth)

50125 (KFKI-71-33) CONSTRUCTION OF THE EFFECTIVE LAGRANGIAN OF PIONIC PROCESSES FOR ARBITRARY SU(2) x SU(2) BREAKING. Hasenfratz, P. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [1969]. 14p. Dep. NTIS (U. S. Sales Only).

By assuming that the SU(2) × SU(2) symmetry is broken by the isoscalar element of the representation (1,1) effective Lagrangians reproducing the results of current algebra and the PCAC assumption can be constructed by a direct method suggested previously. It is shown that the symmetry-breaking parts of these Lagrangians are the solutions (in closed form) of the differential equation for the breaking parts in Weinberg's formalism, and thus the connection between the two approaches is established. (auth)

50126 (NP-18967) DUAL AMPLITUDES AND BASIC ASSUMPTIONS. [PART] I. Kitazoe, Tetsuro; Shinohara, Hideyuki (Kobe Univ. (Japan). Dept. of Physics). [1969]. 29p. Dep. NTIS (U. S. Sales Only).

Four simple assumptions for scattering amplitudes are proposed to derive dual amplitudes. The assumptions are conventional except one which states that each term of an amplitude, corresponding to a certain combination of Regge poles in s, t and u channels, is constructed by a triple product form of three unknown functions, $g_1(t)$, $g_2(s)$ and $g_3(u)$. This is made by an abstraction of the Virasoro type amplitudes. These assumptions lead to difference equations for g's, which can be solved. It is found that the amplitude can be uniquely determined and that it coincides with the amplitudes of Virasoro type and with the ones of Venetiano type when the sums of the trajectories in s, t and U channels are determined by the crossing considerations of isospin. Examples are given for the $\pi\pi \rightarrow \pi\omega$ scattering and the $\pi N \rightarrow \pi N$ scattering. For the latter, it is shown that the A amplitude (in usual notation) obtained coincides with the one proposed previously but the B does not. Then, it is concluded that some daughter trajectories of N and Δ must contribute to the B amplitude. Also our basic assumptions generally exclude the terms with P', N and Δ trajectories for the A amplitude and the terms with ρ, N and Δ trajectories for the B amplitude, which suggests possible existence of some kinds of selection rules. (auth)

50127 (ORO-3992-60) MODIFIED SHIRKOV EQUATIONS IN PION SCATTERING. Atkinson, D. (Texas Univ., Austin. Center for Particle Theory). Jun 1971. 15p. (CPT-110; AEC-60). Dep. NTIS.

A conformal mapping of the momentum-transfer plane is used to remove the divergence in the pion-pion equations in the differential approximation. The new equations, involving "flexible" expansion coefficients, are written down in a form suitable for a rigorous existence proof on the one hand, and for a numerical computation on the other. (auth)

50128 (RPP/C-22) CAN PRESENT INFORMATION ON PION-NUCLEON ELASTIC SCATTERING SOLVE THE UP-DOWN AMBIGUITY FOR THE PION-PION ISOSPIN ZERO S-WAVE? Elvekjaer, F.; Nielsen, H. (Rutherford High Energy Lab., Chilton (England)). Jun 1971. 18p. (CONF-710609-7). Dep. NTIS (U. S. Sales Only)

From international conference on elementary particles; Amsterdam, Netherlands (30 Jun 1971).

Three rather different δ_0^0 phase shifts were investigated namely the Morgan and Shaw favored solution, a characteristic up-up and a characteristic down-up. By means of an Omnes equation and a suitable analytic continuation of the $1 \rightarrow 1$ type the helicity amplitude $f_{\frac{1}{2}}^0(t)$ corresponding to each ansatz for δ_0^0 was obtained, and the helicity amplitudes are then confronted with recent π-N data via partial wave dispersion relations. The results definitely prefer the Morgan and Shaw favored solution. (auth)

50129 ππ LOW-ENERGY CORRECTIONS DUE TO THE POMERON. Corciovei, A.; Ghika, Gr.; Visinescu, M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 1, 11-17(1971).

The purpose is to estimate the corrections due to the Pomeron for the ππ scattering amplitudes at low energy. Using a definite model for the Pomeron and the Adler condition one finds significant corrections for ππ scattering lengths. (auth)

50130 RIGOROUS INEQUALITIES FROM POSITIVITY AND DUALITY IN THE ZERO-WIDTH APPROXIMATION. Coon, D. D.; Geffen, D. A. (Univ. of Minnesota, Minneapolis). Contract AT(11-1)-1764. Phys. Rev. Lett.; 27: No. 9, 627-30(30 Aug 1971).

It is shown that in dual-resonance models with no ghosts the least massive spin-J meson which couples to baryons must have $I = 0$ and $P = C = (-1)^J$ for $J \geq J_0$ (number of subtractions at $t = 0$), e.g., $M_\omega \leq M_\rho$, $M_f \leq M_{A2}$, etc. If degeneracy occurs, e.g., $M_\omega = M_\rho$, then the $I = 0$, $P = C = (-1)^J$ coupling must dominate. Inequalities are found among couplings of arbitrary-spin baryons to leading mesons. For ω-nucleon coupling, $g\gamma^\mu + (if/2m)\sigma^{\mu\nu}q_\nu$, with $M_\omega < M_\rho$ one finds that $g^2 \geq (fM_\omega/2m)^2$. With $\omega-\rho$ degeneracy, $g_\omega^2 - g_\rho^2 \geq (M_\omega/2m)^2|f_\omega^2 - f_\rho^2|$. Bounds on SU(3) mixing angles and baryon masses are also found. (auth)

50131 LARGE ANGLE HADRON SCATTERING AND DUALITY: $K^{+-}p$, $\bar{p}p$ AND pp SCATTERING. Krzywicki, A. (Laboratoire de Physique Theorique et Particules Elementaires, Orsay, France. Ecole Polytechnique, Paris). Nucl. Phys.; B32: No. 1, 149-78 (1971).

Invariant four-point amplitudes satisfying the "mathematical duality" constraints (essentially Regge behavior and meromorphy) are considered. A simple relationship between the fixed momentum transfer (Regge) and fixed angle asymptotic, high-energy behavior is established. The same reduced Regge residue functions appear in the Regge limit and in the fixed angle asymptotic formulas (but with different arguments). The problem of determination of the contribution to the large angle scattering of those direct channel resonances which build the Regge peaks is reduced to the search of the large momentum transfer behavior of the reduced Regge residues. The theory nicely incorporates the crossing symmetry. The general theory is applied to discuss the presently known large angle $K^{\pm}p$, $\bar{p}p$ and pp scattering data. Strong arguments are given in favor of the conjecture that (dual) resonances contribute significantly to large angle scattering in the GeV energy range. The contribution of these resonances decreases exponentially with s (at fixed angle) and becomes unimportant at large enough laboratory energies (around 10 GeV). The observed correlation between the existence of a backward peak and a plateau around 90° is explained. It is claimed that large angle scattering in the GeV region provides information about large momentum transfer behavior of the reduced Regge residues (this behavior seems to be roughly of the $1/t^2$ type). (auth)

50132 GOLDSTONE-NAMBU BOSONS IN DUAL AND PARTON THEORIES. Casher, Aharon; Noskowicz, Simon Henri; Susskind, Leonard (Tel-Aviv Univ., Ramat-Aviv, Israel). Nucl. Phys.; B32: No. 1, 75-92(1971).

XUM

General criteria for a dual or parton theory to have a Goldstone-Nambu boson are conjectured and the consistency of the criteria is proved by demonstrating an exactly solvable model. The amplitudes constructed from this model satisfy all soft-pion theorems or Adler zero conditions. A second unsolvable model based on a ferromagnetic state of the spins of the parton distribution is shown to satisfy the general criteria conjectured on the basis of the first model. (auth)

50133 FERMI–YANG MODEL OF MESONS BASED ON A RELATIVISTIC OBE MODEL. Schierholz, G.; Wagner, S. (Univ., Hamburg). Nucl. Phys.; B32: No. 1, 306-18(1971).

Nucleon-antinucleon ($N\bar{N}$) bound states are calculated in the framework of relativistic quantum mechanics. The potential is taken from a previous investigation of the nucleon-nucleon (NN) interaction due to the exchange of the π, η, σ, ϵ, ρ, and ω mesons with parameters fitted to the NN phase shifts and to the deuteron. The $N\bar{N}$ interaction is given from that of the NN system by changing the sign of the π and ω exchange contributions as a result of crossing symmetry. This way the ω exchange gives rise to a repulsive core for NN and to short-range attractive forces for $N\bar{N}$. In contrast to similar calculations by other authors $N\bar{N}$ bound states below 1000 MeV are obtained in the partial waves bearing the quantum numbers of the input mesons. In addition, there are bound states, mostly between 1000 MeV and threshold, corresponding to the ϕ, ρ', δ, A_1, A_2, f, f', and B mesons. The uncoupled L = J partial waves contain at most one bound state. The coupled L = J ± 1 partial waves $^3S_1 - {}^3D_1$ and $^3P_2 - {}^3F_2$ contain two T = 0 bound states which reflect the mixed singlet-octet mesons ω, ϕ and f, f'. Most of the calculated bound states are close to the corresponding experimentally observed mesons, but the bound states corresponding to the ρ and ω and the fictitious σ mesons appear at negative energies. For the ω and σ mesons this is mainly due to the large π exchange contribution. The $N\bar{N}$ bound state spectrum calculated from pure ω exchange is for a somewhat larger ωN coupling constant than that given from the NN investigation in surprisingly good agreement with the physical (non-strange) meson spectrum if isospin degeneracy is considered. (auth)

Strong (Baryon No. = 1)

Refer also to abstract 50073.

50134 (COO–2009-22) ANALYSIS OF π^+p ELASTIC SCATTERING FROM 2.74 TO 4.0 GeV/c AT ALL ANGLES. Chu, Shu-Yuan; Hendry, Archibald W. (Indiana Univ., Bloomington. Dept. of Physics). Mar 1971. Contract AT(11-1)-2009. 32p. Dep. NTIS.

The π^+p elastic scattering is analyzed in terms of s-channel helicity amplitudes. It is demonstrated that the data are consistent at all angles with the picture of the proton as an absorbing sphere of radius 0.8F, with special edge effects accounting for backward scattering. (auth)

50135 (JINR–E2-5897) GENERAL ANALYSIS OF THE MESON–NUCLEON SCATTERING BASED ON THE FUNCTIONAL INTEGRATION METHOD. Kuleshov, S. P.; Matveev, V. A.; Sisakyan, A. N.; Smondyrev, M. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 12p. Dep. NTIS (U. S. Sales Only).

The expressions in the form of continuous integrals are obtained for the vertex function and the amplitude of the elastic meson-nucleon scattering. (auth)

50136 (JINR–P-2-5906) INVARIANT VARIETIES OF THE CHEW–LOW EQUATION. Meshcheryakov, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

The Chew–Low equations are reduced to the system of nonlinear difference equations. The notions about a stationary point and invariant variety are used for the analysis of the latter equations. It is proved that the Chew–Low equations with three-row matrix of the crossing symmetry have an invariant surface. (auth)

50137 (JINR–P2-5943) APPLICATION OF GENERALIZED VENEZIANO MODEL TO REACTION $\pi^-p \to n\pi^0\pi^0$. Budagov, Yu. A.; Vinogradov, V. B.; Enkovskii, L. L.; Klimenko, S. V.; Martinska, G.; Timokhin, V. V.; Shandor, L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

In the framework of the generalized Veneziano model the reaction $\pi^-p \to n\pi^0\pi^0$ at 1 to 10 GeV is investigated. The total and differential cross sections, the production cross sections of f^0 and Δ^0 (1236) resonances and the angular distributions of secondary particles are calculated. The predictions are compared with the experimental data. (auth)

50138 (JINR–P2-5961) DESCRIPTION OF REACTION $\pi^-p \to NK\bar{K}$ WITH GENERALIZED VENEZIANO MODEL. Budagov, Yu. A.; Vinogradov, V. B.; Enkovskii, L. L.; Klimenko, S. V.; Kukhtin, V. V.; Koutsidi, N. K.; Martinska, G.; Timokhin, V. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 16p. (In Russian). Dep. NTIS (U. S. Sales Only.)

In the framework of the generalized Veneziano model the reactions $\pi^-p \to pK^-K^0$ and $\pi^-p \to nK^0\bar{K}^0$ at 1.5 to 8 GeV/c are investigated. The total and differential cross sections, the effective mass distributions and the angular distributions of secondary particles are calculated. The predictions are compared with the experimental data. (auth)

50139 WARD IDENTITIES, DISPERSION RELATIONS, AND DUALITY FOR πN SCATTERING AT LOW ENERGIES. Hoehler, G.; Stichel, P. (Univ., Karlsruhe, Ger. Univ., Bielefeld, Ger.). Z. Phys.; 245: No. 5, 387-410(1971).

The full one-particle approximation to the Ward identities for πN scattering is investigated, taking into account elastic unitarity in the t-channel for πN- and $\pi\pi$-amplitudes. The results for the one-particle contributions are compared with the corresponding expressions in the dispersion relation approach, where t-channel exchanges are introduced into fixed-t dispersion relations by subtracting the lowest $\pi\pi N\bar{N}$-partial wave amplitudes. The method leads to a prescription for an isobaric model, in which double counting does not occur although s-, t- and u-channel exchanges are superimposed. (auth)

50140 POLARIZATION TEST OF ABSORPTIVE CUT MODELS. Phillips, R. J. N.; Ringland, G. A. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Phys.; B32: No. 1, 131-40(1971).

The Michigan and Argonne versions of the Regge-pole absorption model give different results for the real parts of Regge-exchange amplitudes, and are therefore expected to give different predictions for elastic polarization. It is examined whether one can in fact discriminate between the models in this way. It is concluded that πN scattering is sufficiently simple and well known to provide a meaningful test, and that it favors the Argonne model, based on Regge-poles with wrong-signature residue zeros. KN and $\bar{K}$N scattering are not yet known in enough detail to allow a reliable test. There is supporting evidence, from πN finite energy sum rules, that the real part of the ρ-exchange amplitude follows the Argonne rather than the Michigan model. (auth)

50141 CROSSING-SYMMETRIC DESCRIPTION OF THE COMPLEX $K^+K^-\pi^-p\bar{n}$. Hoyer, P. (CERN, Geneva); Petersson, B.; Lea, A. T.; Paton, J. E.; Thomas, G. H. Nucl. Phys.; B32: No. 1, 285-305(1971).

A crossing symmetric description is given for the reactions in the complex $K^+K^-\pi^-p\bar{n}$. The pion exchange is Reggeized and for the πK interaction the amplitude proposed by Lovelace is used. The vector meson (ρ) exchange is described by a dual five-point amplitude. The prominent features of the reactions studied are then reproduced. In particular, the prominent baryon resonances are found to be dual to ρ exchange. The dual nature of the pion is investigated by constructing a five-point amplitude for pion exchange. The baryons produced by this amplitude are mainly in the daughter states, the parents being quite weakly coupled. (auth)

50142 TOWARDS A SIMPLE INTERPRETATION OF WIDE ANGLE ELASTIC SCATTERING. Carreras, B.; White, J. N. J. (Daresbury Nuclear Physics Lab., Warrington, Eng.). Nucl. Phys.; B32: No. 1, 319-31(1971).

A simple generalization of the "Pomeron + resonances" approach to elastic scattering is considered and agreement is obtained with the structure observed in recent wide angle πN data. (auth)

50143 HYPERCHARGE EXCHANGE LINE-REVERSED REACTIONS AND ASYMPTOTIC MODELS. Irving, A. C.; Martin, A. D. (Univ. of Durham, Eng.). Nucl. Phys.; B32: No. 1, 1-9(1971).

The asymptotic behavior of the line-reversed reactions $\bar{K}N \to \pi\Sigma$, $\pi\Lambda$ and $\pi N \to K\Sigma$, $K\Lambda$ is compared with model predictions. Polarization data favor an exchange-degenerate Regge-cut model and tests involving R and A parameters are discussed. An s channel approach to the observed inequality of line-reversed cross sections at lower energies is presented. (auth)

50144 INTERACTION OF ANTI-PROTONS WITH DEUTERONS IN THE ENERGY RANGE 25 TO 100 MeV. D'yakonov, I. A.

(Moscow Engineering-Physics Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 11, 28-33(1970). (In Russian).

The cross section of elastic p–d scattering was calculated, together with antiproton loading on deuterons, the inelastic decay of a deuteron, and the angular distribution of elastically scattered antiprotons for five energy values. An estimate of the cross section of antiproton annihilation by a deuteron was obtained. The calculations were carried out with the aid of a model described by P. E. Nemirovsky et al (Yadern. Fiz. 5, 277(1967)). (tr-auth)

Strong (Baryon No. ≥ 2)

Refer also to abstract 50809.

50145 (CONF-690732, pp 13,1-39) INVERSE SCATTERING PROBLEM FOR SEPARABLE POTENTIALS AND OFF-SHELL EFFECTS. Fiedeldey, H. (Atomic Energy Board, Pretoria (South Africa)).

From fourth seminar on theoretical physics; Johannesburg, South Africa (7 Jul 1969).

The nucleon–nucleon potential is discussed including the formalism of the S-state Schroedinger equation, the solution for a prescribed bound-state wave function, and off-shell effects in the triton with the Tabakin separable potential of rank one. (J.F.P.)

50146 (JINR–E2-5851) ON THE REPRESENTATION OF SCATTERING AMPLITUDES AS THE CONTINUAL INTEGRALS OVER PATHS IN QUANTUM FIELD THEORY. Matveev, V. A.; Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 28p. Dep. NTIS (U. S. Sales Only).

A new representation of scattering amplitudes as a continual sum over the particle paths is derived in the framework of simple field-theoretical models. The problem of a mass and a wave function renormalization is discussed and the generalization to the inelastic process is given. (auth)

50147 (JINR–P2-5865) THE DOUBLE CHARGE EXCHANGE OF π-MESONS ON NUCLEI AT HIGH ENERGIES. Gevorkyan, S. P.; Tarasov, A. V.; Tseren, Ch. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). Jul 1971. 13p. (In Russian). Dep. NTIS (U. S. Sales Only).

The double charge exchange of π-mesons at high energies ($E_\pi > 2$ GeV) on nuclei, considered as a double stage process, is analyzed in the framework of the Glauber theory. (auth)

50148 (ORO–3765-34) TWO-NUCLEON T-MATRIX HALF OFF THE ENERGY SHELL: A DIRECT APPROACH. Picker, H. S.; Redish, Edward F.; Stephenson, G. J. Jr. (Maryland Univ., College Park). Dec 1970. 43p. Dep. NTIS.

The T-matrix half off the energy shell can be expressed in terms of the on-shell T-matrix and the difference between the full scattering wave function and the phase-shifted free wave function. This representation allows one to investigate variations in the half-shell T-matrix by means of a parametrization of the scattering wave function in the interaction region. Most of the knowledge of the physical constraints on that wave function may then be included. In particular the arbitrariness remaining in the half-shell T was studied and given the following constraints: the on-shell T is given, a specific local potential acts beyond a certain radius, and the wave function is suppressed at short distances. Models of the $^1S_0$ two-nucleon half-shell T matrix were constructed. In a simple one-parameter model satisfying these constraints, the range of variation of the near off-shell behavior is displayed. (auth)

50149 NUCLEON AND PION STAR PRODUCTION FROM HIGH-ENERGY (>40 GeV) PROTONS INCIDENT ON IRON. Santoro, R. T.; Gabriel, T. A. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods; 95: No. 2, 369-70(1971).

Nucleon and pion star production from 40- to 1000-GeV protons incident on iron is calculated. Star yields above cutoff energies of 15 and 100 MeV are reported. (auth)

50150 EXPLANATION OF EXCESS HIGH-MOMENTUM SPECTATORS IN HIGH-ENERGY DEUTERON-BREAKUP REACTIONS. Dean, Nathan W. (Ames Lab., Iowa). Phys. Rev. Lett.; 27: No. 5, 276-9(2 Aug 1971).

The multiple-scattering correction to the spectator momentum distribution is calculated using Glauber theory. It is shown to dominate when the transverse component of the spectator momentum is greater than about 400 MeV/c, yielding an overall enhancement of high-momentum events. (auth)

50151 PROTON–PROTON AND PION–PROTON INELASTIC COLLISIONS AND THE PROTON AND PION FORM FACTORS. Sosnowski, R.; Wojcik, W. (Univ., Warsaw). Nucl. Phys.; B32: No. 1, 205-13(1971).

A model of proton-proton inelastic collisions at high energies is proposed. It assumes that the amplitude for a collision in which n secondary particles are produced is a product of n form factors identical with the charge form factor of the proton. The predictions of the model are compared with the experimental data. The main characteristics of the experimental distributions of secondary particles are well reproduced by the model. The experimental data on high-energy pion-proton collisions are also compared with the prediction of the model. (auth)

50152 NATURE OF THE EXCHANGES IN THE REACTIONS pp → BARYON + BARYON + PION AT 19 GeV/c BY ANALYSIS OF DIFFERENTIAL CROSS SECTIONS. Boeggild, H. (Univ. of Copenhagen); Dahl-Jensen, E.; Hansen, K. H.; (and others). Nucl. Phys.; B32: No. 1, 119-30(1971).

A study of some four-momentum and angular distributions in reactions of the type pp → baryon + baryon + pion, at 19 GeV/c is presented. The fraction pp → NNπ is divided into two parts: pp → N(Nπ)I = 3/2 and pp → N(Nπ)I = 1/2. These two parts show some significant differences. While the first part shows features, which remind one of pion-nucleon scattering and therefore suggest that this channel contains an important contribution of pion-exchange, the second part has a different structure suggesting that this channel is dominated by some other type of exchange. Similar features are seen in the reaction pp → $\Delta^{++}p\pi^-$. (auth)

50153 SCALING HYPOTHESIS, LIMITING FRAGMENTATION, AND THERMODYNAMIC MOMENTUM SPECTRA. Ranft, J. (Karl Marx Univ., Leipzig). Phys. Lett.; 36B: No. 3, 225-8 (6 Sep 1971).

The scaling behavior of the thermodynamic particle spectra is studied using the rapidity variable r. Between 20 and 500 GeV/c the thermodynamic spectra behave not as expected from the scaling hypothesis. Reasons for this behavior are discussed. A comparison with recent cosmic ray data indicates that scaling is probably not yet present at accelerator energies. The structure function of the inclusive π^+-spectra from p-p-collisions according to the thermodynamic model is calculated for small longitudinal momenta in the laboratory system, and is found already nearly independent on primary proton momentum between 10 and 100 GeV/c. (auth)

50154 REGGE ANALYSIS OF MASSIVE MUON-PAIR PRODUCTION. Galfi, L. (Roland Eoetvoes Univ., Budapest); Koegerler, R. Phys. Lett.; 36B: No. 3, 218-24(6 Sep 1971).

A Regge analysis of the p + p′ + q – forward scattering is used to study the behavior of muon-pair production by inelastic hadron-hadron collision in different Regge-limits. Regge-hypothesis and factorization assumption lead to a natural interpretation for both the slope and the precise functional dependence of the data of the BNL-Columbia experiment. (auth)

50155 STRUCTURE FUNCTIONS FOR INELASTIC PROTON–PROTON SCATTERING AT DIFFERENT ENERGIES. Chliapnikov, P. V.; Czyzewski, O.; Goldschmidt-Clermont, Y. Phys. Lett.; 36B: No. 3, 235-7(6 Sep 1971).

Present data for proton-proton interactions in the region from 6 to 30 GeV/c show a strong energy dependence of the structure function defined for inelastic p-p scattering in the deep inelastic region. This contrasts with the behavior of the structure function for inelastic electron-proton scattering. (auth)

50156 COULOMB EFFECTS AND THE QUESTION OF CHARGE-SYMMETRY BREAKING IN LOW-ENERGY PD SCATTERING. Avishai, Y. (Argonne National Lab., Ill.); Rinat, A. S. Phys. Lett.; 36B: No. 3, 161-4(6 Sep 1971).

Perturbation techniques are applied to dispersion relations for nucleon–dueteron scattering. It is shown that additional Coulomb effects account for the pd quartet scattering parameters and in particular for the large difference in pd and nd quartet scattering lengths. Results for the doublet, l = 0 phase seem to disagree with current inaccurate data. Another datum of the same channel, namely the Coulomb energy, appears close to the observed $^3H-^3He$ mass difference. (auth)

50157 EFFECTIVE INTERACTIONS FOR INELASTIC DEUTERON SCATTERING. Satchler, G. R. (Oak Ridge National Lab., Tenn.). Phys. Lett.; 36B: No. 3, 169-72(6 Sep 1971).

The effective nucleon–deuteron interaction to be used in a microscopic description of inelastic scattering is discussed. Reasonable agreement with experiment is obtained when exchange

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terms and a phenomenological imaginary interaction are included. (auth)

50158 NEUTRON–DEUTERON SCATTERING LENGTHS. Dilg, W.; Koester, L.; Nistler, W. (Technische Univ., Munich). Phys. Lett.; 36B: No. 3, 208-10(6 Sep 1971).

New measurements of the n-d coherent scattering amplitude and epithermal cross section are reported. The results $a_{coh} = 6.672 \pm 0.007$ fm, $\sigma_{free} = 3.390 \pm 0.012$ b, are inconsistent with the scattering lengths, proposed by Van Oers and Seagrave. From the present data one obtains $a_2 = 0.65 \pm 0.04$ fm, $a_4 = 6.35 \pm 0.02$ fm for the doublet and quartet n-d scattering lengths, respectively. (auth)

50159 EVALUATION OF THE TRIPLE-POMERANCHUKON-VERTEX $\eta_{PPP}(t)$ FROM EXPERIMENT AS A FUNCTION OF t. Rajaraman, R. (Delhi Univ.). Phys. Rev. Lett.; 27: No. 10, 693-6(6 Sep 1971).

It is shown that the squared coupling constant $\eta_{PPP}(t)$ connecting three Pomeranchukons, which has acquired considerable interest recently, can be evaluated directly from experiment. Data at 24 GeV/c for the reaction $p + p \rightarrow p +$ background are used for this purpose. It is found that $\eta_{PPP}(0) = 0.005$ is consistent with theoretical estimates. Further, $\eta_{PPP}(t)$ falls very rapidly at t goes from 0 to -1.5 $(GeV/c)^2$. (auth)

50160 LAMBDA-NUCLEON SCATTERING LENGTHS. Dutta-Roy, B.; Mahalanabis, J.; Bhowmick, K. (Saha Inst. of Nuclear Physics, Calcutta). pp 248-50 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28-31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

Particle Invariance Principles and Symmetries

General

50161 (JINR-P-2-5914) CALCULATION OF THE STATISTICAL WEIGHTS IN SU_6-SYMMETRY OF THE MULTIPLE PARTICLE PRODUCTION. Barashenkov, V. S.; Bestojev, Kh. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1971. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

Algebraic correlations are obtained which connect irreducible SU_n group representations and allow the characters and dimensions of these representations to be simply calculated. Within the framework of SU_6 group the expansion coefficients of the state (which is characterized by definite quantum numbers) to a given number of SU_6 multiplets, are obtained. (auth)

50162 (ORO-3992-38) GENERALIZED EIGENVECTORS AND GROUP REPRESENTATIONS: THE CONNECTION BETWEEN REPRESENTATIONS OF SO(4,1) AND THE POINCARE GROUP. Boehm, A. (Texas Univ., Austin. Center for Particle Theory). Feb 1971. 75p. (CPT-89). Dep. NTIS.

Lectures are presented on the rigged Hilbert space method in noncompact group representations for a physically important example. The relation between representations of SO(4,1) and the Poincare group is discussed. (J.F.P.)

50163 (PURC-4159-34) EXPERIMENTAL STUDY OF THE TAU MATRIX ELEMENT. Technical Report No. 8. Remmel, Ronald S. (Princeton Univ., N. J. Elementary Particles Lab.). Jun 1971. Contract AT(30-1)-4159. 203p. Dep. NTIS.

Thesis.

The Dalitz-plot distribution of the first 650,000 tau decays ($K^{\pm} \rightarrow \pi^{\pm}\pi^{\pm}\pi^{\mp}$) out of 3 million taus detected was constructed. A Cerenkov counter identified kaons in a 3.0-GeV/c partially separated beam at the Brookhaven AGS. The directions of all three pions which had given a three-fold coincidence in an eight-counter hodoscope were measured by five wire spark chambers. These chambers and three pairs of chambers behind a wide-aperture magnet served to measure the momentum of the odd pion. A comparable number of Monte Carlo events was used to normalize the data to phase space corrected for Coulomb interactions in the final state. Linear and quadratic fits to the square of the matrix element in terms of Dalitz–Fabri variables are: $|M|^2 = 1 + (0.273 \pm 0.006)$ Y and $|M|^2 = 1 + (0.279 \pm 0.006)$ Y + (-0.031 ± 0.030) X^2 + (0.029 ± 0.014) Y^2. (auth)

50164 SIMULTANEOUS REALIZATION OF SU(3) ⊗ SU(3) AND DILATION SYMMETRY. Mathur, Vishnu S. (Univ. of Rochester, N. Y.). Phys. Rev. Lett.; 27: No. 7, 452-5(16 Aug 1971).

It is shown that if the chiral SU(3) ⊗ SU(3) and scale-invariant limits coincide, chiral-symmetry breaking by $(3,3^*) \oplus (3^*,3)$ terms provide a consistent description incorporating the previous results. (auth)

50165 FAILURE OF THE PERTURBATION EXPANSION ABOUT THE SU(3) ⊗ SU(3) LIMIT. Carruthers, P.; Haymaker, Richard W. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett.; 27: No. 7, 455-8(16 Aug 1971).

It is suggested that perturbation-theory corrections to the limit of spontaneously broken SU(3) ⊗ SU(3) symmetry fail because of the existence of a radius of convergence which is much smaller than the experimental values of the symmetry-breaking parameters. The results are compatible with SU(3) being a good symmetry for states even though the Lagrangian has approximate SU(2) ⊗ SU(2) symmetry. (auth)

Applications (Electromagnetic and Weak)

50166 (CONF-690732, pp 12,1-14) THEORY OF ELEMENTARY PARTICLES DRIVED FROM REPRESENTATIONS OF THE UNITARY GROUP. de Wet, J. A.

From fourth seminar on theoretical physics; Johannesburg, South Africa (7 Jul 1969).

Representations of U_n^0 are associated with elementary particles. The representations of U_2^0 carry the spins and isospins of electrons, and representations of U_4^0 are associated with nucleons and Ξ particles. The example of U(2) is used, followed by a summary of results for U(4) and U(8). (J.F.P.)

Field Theories

General

50167 (JINR-E2-5976) BOGOLYUBOV TRANSFORMATION IN STRONG COUPLING THEORY. Solodovnikova, E. P.; Tavkhelidze, A. N.; Khrustalev, O. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 29p. Dep. NTIS (U. S. Sales Only).

Systems with strong interaction which are invariant under translations are considered. The Bogolyubov transformation makes it possible to take into account explicitly conservation laws, construct a perturbation series in the small parameter and find stationary states of the system in the first approximation. In the case of the interaction of a classical relativistic particle with a scalar field an equidistant squared mass spectrum is obtained. (auth)

50168 (ORO-3992-57) CROSSING SYMMETRIC BETHE-SALPETER EQUATIONS AND THE GENERALIZED LADDER GRAPHS. Johnson, Porter W. (Illinois Inst. of Tech., Chicago. Dept. of Physics); Yaes, Robert J. (Illinois Inst. of Tech., Chicago. Dept. of Physics. Texas Univ., Austin. Center for Particle Theory). May 1971. 12p. (CPT-107; AEC-57). Dep. NTIS.

It is shown that the Bethe–Salpeter equations with s–u crossing symmetry and t exchange generate all the generalized ladder graphs to sixth order. To eighth and higher order, a subset of the generalized ladder graphs is generated but not all of them. The discussion is limited to scalar electrodynamics. (J.F.P.)

50169 ELECTROMAGNETIC COMPENSATING GAUGE TRANSFORMATIONS. Janner, A.; Janssen, T. (Katholieke Univ., Nijmegen, Netherlands). Physica; 53: No. 1, 1-27(17 May 1971).

Electromagnetic potentials have, in general, a smaller space-time symmetry than the corresponding fields. But to each symmetry element of the field a compensating gauge transformation can be found such that the combination of the two leaves the potential invariant. The same is true for the space-time symmetry of equations of motion of charged particles in external electromagnetic fields. Combining gauge with space-time transformations, one constructs symmetry groups of potentials and invariance operator groups of equations of motion. Their interrelation for arbitrary fields, in the classical and in the quantum-mechanical case, for relativistic and for nonrelativistic symmetry transformations, are discussed. Potentials which differ only by a gauge transformation give rise to isomorphic invariance operator

groups. The case of a linearly polarized transverse electromagnetic plane wave is briefly discussed. (auth)

50170 NONEXISTENCE OF ISOLATED CHARGE DISTRIBUTION IN BONNOR'S UNIFIED FIELD THEORY. Tiwari, R.; Pant, D. N. (Banaras Hindu Univ., India). Phys. Lett.; 36A: No. 2, 145-6(16 Aug 1971).

A static spherically symmetric solution representing the external field of an isolated charge distribution does not exist in Bonnor's unified field theory. (auth)

Quantum Field Theory

Refer also to abstracts 50109, 50186, and 50187.

50171 (JINR-E2-5922) STOCHASTIC SPACES. Blokhintsev, D. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 13p. Dep. NTIS (U. S. Sales Only).

The phase fluctuations of the wave propagating in a stochastic homogeneous medium, particularly in a physical vacuum, are calculated. The notion of stochastic space is introduced. It is shown that to obtain convergent results in the relativistic case it is necessary to introduce a "cut-off" factor. (auth)

50172 (ORO-3992-19) KERNELS REALIZING ASSOCIATIVE MULTIPLICATIONS BETWEEN PHASE SPACE FUNCTIONS. Simoni, A.; Sudarshan, E. C. G.; Zaccaria, F. (Texas Univ., Austin. Center for Particle Theory). [1969]. 13p. (AEC-19; CPT-69). Dep. NTIS.

Some features of the possible correspondence between spaces of c-number functions and classes of linear operators on Hilbert spaces, as realizations of the quantum mechanical scheme were previously studied. The general problem is proposed and solved. (L.B.S.)

50173 (ORO-3992-44) QUANTUM FIELD THEORIES WITH SHADOW STATES. I. SOLUBLE MODELS. Nelson, C. A.; Sudarshan, E. C. G. (Texas Univ., Austin. Center for Particle Theory). Mar 1971. 57p. (CPT-94; AEC-44). Dep. NTIS.

To construct a finite local relativistic quantum field theory one may introduce an indefinite metric vector space, but then to avoid conflict with unitarity one must consider only a selected subset of states to be physical. The remaining states participate in the dynamics but are not among the complete set of physical states as far as probability interpretation is concerned. These states are called shadow states. The S-matrix should be unitary when restricted to the physical states. Several simple models of field theories with shadow states are formulated and solved, and the manner in which shadow states influence the dynamics and the structure of the scattering is demonstrated. (auth)

50174 SPECIFIC CORRELATION EFFECT IN THE QUANTUM THEORY OF FREE ELECTROMAGNETIC RADIATION. Vinson, Jean-Francois (Univ., Paris). Compt. Rend., Ser. B; 272: No. 22, 1240-3(2 Jun 1971). (In French).

A specifically quantum correlation effect is established for field states in which the density operator does not possess a diagonal representation belonging to the space of tempered distributions. (France)

50175 VACUUM POLARIZATION FOR STRONG EXTERNAL FIELDS AND THE SELF-CONSISTENT METHOD IN QUANTUM ELECTRODYNAMICS. Fulcher, L. P.; Greiner, W. (Univ., Frankfurt am Main). Lett. Nuovo Cim.; 2: No. 6, 279-84(7 Aug 1971).

The single-particle Dirac equation for an electron bound to a nucleus, which was taken to be a uniformly charged sphere, is discussed. The energy eigenvalues obtained for several of the lower atomic orbitals as a function of nuclear charge are considered. As an alternative to a previous definition of a vacuum it is suggested that all negative-energy bound and continuum states be filled and that the charge be set equal to zero. The new method is based on an extension of the Hartree–Fock method to include positive- and negative-energy continua and unoccupied bound states. It is found that the results do not indicate that the vacuum polarization corrections to atomic energy levels change sign for strong fields. (J.F.P.)

50176 FIELD THEORY AND UNSTABLE PARTICLES. Steinmann, O. (Schweizerisches Institut fuer Nuklearforschung, Zurich). Helv. Phys. Acta; 44: No. 5, 618-41(15 Aug 1971).

A field theoretical description is given of scattering processes involving long-lived unstable particles. A model with one kind of unstable particles, the B, and their stable decay products, the A, is discussed. The B is described by poles on the second sheet in the otherwise smooth Green's functions of a relativistic quantum field corresponding to the A. The decay is assumed to be due to a weak interaction, and the quantities of the theory are considered only in the two lowest non-vanishing orders in its coupling constant. Strong interactions of the B among themselves and the A among themselves are admitted and are rigorously taken into account. The consequences of unitarity are studied. It is shown that a pole with a factorizing residue on the second sheet of the 4-point function enforces the existence of such poles in the higher functions. The spatio-temporal development of scatterings involving B-particles, as seen in experiments, is analyzed with the help of a formalism developed in an earlier work. A natural definition of incoming and outgoing scattering states and of the S-matrix is given. (auth)

50177 RENORMALIZATION OF NONPOLYNOMIAL LAGRANGIANS. Keck, B. W.; Taylor, J. G. (Univ. of Southampton, Eng.). J. Phys., A (London); 4: No. 4, 441-55(Jul 1971).

With chiral Lagrangians in mind, Lagrangians were studied whose Dyson index is nonnegative, for which the problem is the removal of the ultraviolet divergencies that remain after the usual resummation over the minor coupling constant. It was shown that for any rational interaction Lagrangian without derivatives and of Dyson index less than four, these divergences may be removed in all orders by local counter-terms. This is a special case of a more general result, namely that the method of local counter-terms works if $L_{int} = L_p + L_{np}$, where L_p is a polynomial of Dyson index less than four and L_{np} is a nonpolynomial for which the resummation leaves no divergences. The counter-terms are presented explicitly after resummation over the minor coupling constant. (auth) (UK)

50178 LARGE-ORDER BEHAVIOR OF PERTURBATION THEORY. Bender, Carl M. (Massachusetts Inst. of Tech., Cambridge); Wu, Tai Tsun. Phys. Rev. Lett.; 27: No. 7, 561-5 (16 Aug 1971).

The large-order behavior of perturbation theory is examined for the anharmonic oscillator, a simple quantum-field-theory model. New analytical techniques are exhibited and used to derive formulas giving the precise rate of divergence of perturbation theory for all energy levels of the x^{2N} oscillator. Higher-order corrections to these formulas for the x^4 oscillator with and without Wick ordering are computed. (auth)

Gravitation and General Relativity

Refer also to abstracts 49687, 49688, 49691, and 49694.

50179 (JINR-P-2-5934) ENERGY OF THE SYSTEM OF MANY BOSONS BOUNDED BY THE FORCES OF GRAVITATIONAL ATTRACTION. Zastavenko, L. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 7p. (In Russian). Dep. NTIS (U. S. Sales Only).

An expression is obtained for the energy of the ground state of the system of N bosons interacting by means of the forces of gravitational attraction. The diagonal part is the main one in the $\psi(x)$ operator at $N \to \infty$; this part determines the main part in the expansion E_N at $N \to \infty$. (auth)

50180 (ORO-3992-21) DIRAC THEORY WITH SYMMETRIC TENSOR COUPLING AND ITS APPLICATION TO THE GRAVITATIONAL RED SHIFT. Lipps, F. W. (Texas Southern Univ., Houston. Dept. of Mathematics). [nd]. 22p. (CPT-71; AEC-21). Dep. NTIS.

An effort is made to explain the gravitational red shift in terms of an atomic energy level displacement which is produced by a coupling of the form $G_{\mu\nu}T^{\mu\nu}(\psi)$ in flat space-time geometry. The coupling scheme appears to be in agreement with planetary motion, light-bending, and weak equivalence down to the electromagnetic interaction, but it causes roughly twice the observed red shift. The failure of direct coupling suggests the existence of a massive intermediate particle. Symmetric tensor coupling in the Dirac equation leads to gradient terms and a normalization problem, which is solved at the expense of defining a modified norm in the Hilbert space of spin $\frac{1}{2}$ particles. (auth)

50181 SOME INTERPRETATIONS OF THE DEVIATION FUNCTION IN THE MINKOWSKI SPACE-TIME. Vincensini, Dominique. Compt. Rend., Ser. A; 272: No. 20, 1353-6(17 May 1971). (In French).

Some properties of the Minkowski space-time are deduced from the metric introduced previously. (France)

XUM

50182 PARTICLE GRAVITATION THEORIES OF THE HOYLE–NARLIKAR TYPE. McIntosh, C. B. G. (Monash Univ., Clayton, Australia). J. Phys., A (London); 4: No. 4, 491-500(Jul 1971).

In the Hoyle–Narlikar particle theory of gravitation, the mass function at a point X due to a particle a is defined as $m^{(a)}(X) = -\lambda\int\tilde{G}(X,A)da$ where $\tilde{G}(X,A)$ is a Green's function which satisfies a simple wave equation. The coupling constant λ is replaced by λ_a where λ_a can be positive or negative. Two possible subsequent generalizations of the action of the Hoyle–Narlikar theory are suggested and the two resultant particle theories developed. One special case of one of these theories is examined in some detail. This has particles which contribute negative inertia as well as those which contribute positive inertia and all the λ_a such that $|\lambda_a| = \lambda$. In this theory the gravitational "constant" G is a function of position and can be positive or negative. (auth) (UK)

50183 HOW DOES ONE MEASURE TORSION OF SPACE–TIME. Hehl, F. W. (Institut fuer Theoretische Physik Clausthal-Zellerfeld, Ger.). Phys. Lett.; 36A: No. 3, 225-6(30 Aug 1971).

Introducing spin in general relativity on a dynamical level for space-time leads one to a Riemann–Cartan geometry with torsion. Torsion can be measured by means of a test particle with spin possessing a canonical energy-momentum tensor with a non-vanishing antisymmetric part. (auth)

Scattering Theory

Refer also to abstracts 50031, 50034, 50173, and 50874.

50184 (COO–264-581) NONPLANAR DUAL LOOP IN THE VARIABLES s,t,u. Karpf, Armin D. (Chicago Univ., Ill. Enrico Fermi Inst.). May 1971. Contract AT(11-1)-264. 12p. (EFI–71-35). Dep. NTIS.

Starting from the Lovelace form a closed expression is derived for the four-particle nonplanar dual loop amplitude in terms of the Mandelstam variables s, t and u. The knowledge of this form is essential for the evaluation of the asymptotic and analytic properties in these variables. (auth)

5 185 (JINR–E2-5938) PATH INTEGRATION METHOD AND SEMICLASSICAL APPROXIMATION FOR THE POTENTIAL SCATTERING AMPLITUDE. Pervushin, V. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 17p. Dep. NTIS (U. S. Sales Only).

A semiclassical approach to the scattering amplitude is developed by using the path integration method. The case of a Gaussian potential is considered. In the small-angle diffractional domain, for an arbitrary ratio of the potential energy to the incident kinetic one the values of the scattering amplitude are found to be the same both in the semiclassical and simpler eikonal approximations. The change of the semiclassical scattering behavior with increasing potential energy is discussed, as well. (auth)

50186 (ORO–3992-20) COMPLETENESS OF STATES, SHADOW STATES, HEISENBERG CONDITION, AND POLES OF S-MATRIX. Biswas, S. N.; Pradhan, T.; Sudarshan, E. C. G. (Texas Univ., Austin. Center for Particle Theory). Aug 1970. 24p. (CPT–70; AEC–20). Dep. NTIS.

A study of the connection between poles of S-matrix and states of the Hamiltonian of nonrelativistic quantum mechanical systems is made with a view to elucidate the concept of shadow states which were used previously for the elimination of divergences in quantum field theory with the aid of indefinite metric. By specific examples it is demonstrated that there exist nonrelativistic systems for which the S-matrix has poles which correspond to shadow (redundant) states which are not needed in the completeness relation. Systems with such states do not fulfill a condition on S-matrix which was derived by Heisenberg. It is further shown that there exist phase equivalent systems in which these very poles of the S-matrix correspond to genuine bound states which are absolutely necessary to complete the set of states of the system, and these discrete states may have positive or negative norm depending on the choice of the S-matrix. (auth)

50187 (ORO–3992-36) INFINITE SET OF QUASIPOTENTIAL EQUATIONS FROM THE KADYSHEVSKY EQUATION. Yaes, Robert J. (Texas Univ., Austin. Center for Particle Theory. Illinois Inst. of Tech., Chicago. Dept. of Physics). Jan 1971. 12p. (CPT–87; AEC–36). Dep. NTIS.

It is shown that by modifying the propagator in the Kadyshevsky equation, one can obtain an infinite set of quasipotential equations which satisfy both Lorentz covariance and elastic unitarity and of which the Logunov-Tavkhelidze-Blankenbecler-Sugar-Alessandrini-Omnes equation and the Gross equation are special cases. It is also shown that a previous perturbation scheme for using the quasi-potential equation to obtain approximations to the Bethe-Salpeter equation can be greatly simplified by the use of resolvant-identity-type arguments. (auth)

50188 (ORO–3992-41) NEW APPROACH TO UNSTABLE STATE THEORY. POTENTIAL SCATTERING CASE. Agodi, A.; Baldo, M. (Catania Univ. (Italy). Istituto di Fisica Teorica); Recami, E. (Texas Univ., Austin. Center for Particle Theory). Mar 1971. 20p. (CPT–91; AEC–41). Dep. NTIS.

A method developed previously was followed, for analyzing the effects produced by an internal virtual state $|\phi>$ on the transition amplitudes: In particular, for singling out the necessary conditions for $|\phi>$ to be connected with a resonance in the cross section. In the case of the potential scattering, for instance, the equivalence between the resonance determination was previously shown by means of the Kapur & Peierls method and the determination of the spectral function of a quasi self-adjoint operator (whose "imaginary part" is defined by only one state). In general, by associating unstable states with the eigenvectors of quasi self-adjoint Hamiltonians (eigenstates which are shown to decay correctly), one can study resonances and bound states within the same framework. The application of this method to the study of the resonances related to a spherical-well-potential seems to confirm the validity of the method. (auth)

50189 (ORO–3992-48) SHADOW CHANNELS IN POTENTIAL THEORY. Moore, R. J. (Texas Univ., Austin. Center for Particle Theory). Mar 1971. 16p. (CPT–98; AEC–48). Dep. NTIS.

The effect of coupling a shadow channel to a real channel is studied in the framework of nonrelativistic potential scattering theory. For simplicity, s-wave scattering with energy-independent delta-function potentials is considered. This model has the virtue of being exactly solvable in configuration space. The main features of the solution, which are analogous to those expected in a relativistic field theory whose divergences have been removed using Sudarshan's shadow states, are as follows. The coupled-problem reduces in the real channel to scattering by an effective energy-dependent pseudopotential. The physical scattering amplitude still satisfies elastic unitarity at all energies, but is piecewise analytic with a point of nonanalyticity occurring at the threshold for the shadow channel. (auth)

50190 EIKONAL EXPANSION. Wallace, S. J. (Univ. of Washington, Seattle). Contract AT(45-1)-1388. Phys. Rev. Lett.; 27: No. 9, 622-5(30 Aug 1971).

An eikonal expansion is considered which yields an impact-parameter representation for the scattering T matrix. The dependence on momentum transfer is summed to all orders by means of a conjecture to obtain a standard impact-parameter representation. As a result, phase-corrected eikonal formulas are obtained which are shown to improve on the Glauber approximation systematically at large scattering angles, in contrast to the Abarbanel–Itzykson approximation. Regge behavior is found. (auth)

50191 MULTI-PARTICLE QUANTUM SYSTEMS BELOW THE FOUR-PARTICLE THRESHOLD. Schtalheim, Alex (Eidgenoessische Technische Hochschule, Zurich). Helv. Phys. Acta; 44: No. 5, 642-61(15 Aug 1971).

In the time independent approach to the scattering theory of a quantum mechanical system of N nonrelativistic particles, the wave operators are expressed in terms of amplitudes satisfying the Faddeev-Yakubovsky equations. These equations are studied for energies below the four particle threshold s_4. A graphical method is introduced to classify and analyze the singular integrals occurring in the iterated Yakubovsky kernels. Under a certain spectral assumption, the Fredholm alternative is established. Partial asymptotic completeness of the scattering states below s_4 follows. (auth)

50192 DOES THE LIGHT CONE DOMINATE THE ASYMPTOTIC BEHAVIOR OF VERTEX FUNCTIONS AND SCATTERING AMPLITUDES. Sucher, J.; Woo, C. H. (Univ. of Maryland, College Park). Phys. Rev. Lett.; 27: No. 10, 696-9(6 Sep 1971).

The hypothesis of leading light-cone singularity dominance is examined for vertex functions in the so-called A limit with $\omega = 1$ and for scattering amplitudes in the Regge limit. It is shown that, in the field expansion, terms less singular on the light cone must be as important asymptotically as the more singular terms, unless the asymptotic behavior changes abruptly when an external leg goes slightly off the mass shell. (auth)

Particle Accelerators

Refer also to abstracts 48934, 48980, 49007, 49031, 49045, 49051, 49070, 49071, 49384, 49853, 49855, 49856, 49963, 50042, 50591, 50598, and 50599.

50193 (AECL–3907) SOME ADVANCED RESEARCH USES OF CANADIAN REACTORS AND ACCELERATORS. Bartholomew, G. A.; Boyd, A. W.; Davies, J. A.; Knowles, J. W.; Swanson, M. L.; Tunnicliffe, P. R.; Woods, A. D. B.; Warren, J. B. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Jun 1971. 35p. (TRI-PP-71-3). Dep. NTIS (U. S. Sales Only). AECL $1.00.

A survey is given of some present applications of Canadian accelerators and reactors in the fields of ion implantation and channelling, electron pulse radiolysis, irradiation-induced defects in solids, static and dynamic structure studies by neutron scattering, neutron capture γ-rays, and photoexcitation of nuclear states. Electronuclear breeding and its relevance to the intense neutron generator program, now discontinued, are discussed briefly. A summary is given of the beam characteristics and anticipated performance of the TRIUMF facility. (auth)

50194 (BNL–16006) SMALL APERTURE HIGH-FIELD BENDING MAGNET. Parzen, G.; Jellett, K. (Brookhaven National Lab., Upton, N. Y.). 1 Jul 1971. 8p. Dep. NTIS.

A small-aperture high-field bending magnet is proposed and studied for possible use in a high-energy superconducting accelerator. The aperture is 1.5 × 1.5 in. and the maximum field is 40 kg. The magnet resembles an H magnet, and retains some of the advantages of the simplicity of a window-frame magnet, while possessing an exceptionally flat field, especially at the low- and high-field ends. (auth)

50195 (BNL–16043) HIGH-FIELD BENDING MAGNETS. Parzen, G.; Jellett, K. (Brookhaven National Lab., Upton, N. Y.). 30 Jul 1971. 6p. Dep. NTIS.

A small-aperture, high-field beiding magnet having an aperture of 1.5 × 1.5 in. and a maximum field of 40 kG is considered. The magnet is an H-magnet and the field is corrected by means of two separately excited correction coils. (auth)

50196 (CEAL–1055) SEMIANNUAL REPORT, JULY 1–DECEMBER 31, 1970. Strauch, K.; Shurcliff, W. (Cambridge Electron Accelerator, Mass.). 1 Jun 1971. Contract AT(30-1)-2076. 45p. Dep. NTIS.

Essentially all effort is now being concentrated on the colliding beam project (BYPASS) and the two detection systems (BOLD and MAGNOLIA) being built to analyze the results of the colliding beam events. Progress made in Project BYPASS is summarized. As a result of improvements in the control system and procedures for multicycle injection, single-beam circulating e^- and e^+ currents of 70 and 25 mA peak in the cycling mode were achieved. Methods of converting to dc storage were improved and e^+ and e^- currents of 7 and 10 mA peak (at 2.7 GeV energy in each beam) were maintained simultaneously in the circular orbit. The efficiency of switching a dc stored beam into the 150-ft-long low-beta bypass was improved, and a 25-mA peak electron beam was switched into the bypass without loss. Countertraveling e^+ and e^- beams of a few mA peak current each were obtained. Since these beams were not spatially separated, if one beam had much higher current than the other, the latter was quickly destroyed by a beam-beam instability. The bypass on-line detector (BOLD), the assembly and testing of which is nearly completed, is described. The quadrants of the detector core have been found to provide the planned resolution, single-spark and multi-spark efficiencies. The magnetic on-line detector (MAGNOLIA), which will be needed in the analysis of hadron events, is described. The revised design will employ the 64″ × 98″ rectangular solenoidal coil (providing 5000 gauss) procured for the earlier design of magnetic detector, and will employ wire chambers and proportional chambers. Also, the repairs and improvements to the accelerator proper are discussed. The new, higher-power (200-kW average) rf system was installed and made ready for routine use. Important improvements were made also in the vacuum system, injection controls, and regulation of magnet-ring excitation. Major publications are listed. (auth)

50197 (CONF-710402–(Vol.2), pp I.128-35) ISOTOPIC NEUTRON SOURCES FROM THE LOS ALAMOS MESON PHYSICS FACILITY. O'Brien, Harold A. Jr.; Schillaci, Mario E. (Los Alamos Scientific Lab., N. Mex.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

After passing through several principal target areas, the main beam of the LAMPF accelerator will reach the main beam-stop with approximately ½ mA of 700-MeV protons. This excess beam of high-energy protons will be utilized for the production of radionuclides, which, at this energy, takes place primarily by spallation reactions. The principal features of the LAMPF accelerator and the conceptual design of the Isotope Production Facility are described. The systematics used to estimate the spallation reaction cross sections are discussed together with thick-target considerations. Several examples of yields of radionuclides that are potentially useful for photoneutron sources are given. One of the more promising examples is that of 107-day ^{88}Y, of which approximately 75 Ci/month can be produced with exceptionally high specific activity from a one-inch-thick zirconium target. An ^{88}Y–Be source will emit 150-keV neutrons with an intensity of about 3×10^6 n/sec/Ci. The LAMPF machine, which is scheduled to achieve full beam in July 1972, will make available, in commercially useful quantities, several photoneutron sources with a variety of neutron energies. This will represent a significant expansion in the available supply of such sources and will, hopefully, stimulate further applications. (auth)

50198 (IPP–0/7) PROPERTIES OF AN ELECTRON SOURCE WITH LASER-INDUCED ELECTRON EMISSION. Siller, G.; Buchelt, E.; Schilling, H. B. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Apr 1971. 27p. Dep. NTIS (U. S. Sales Only).

Measurements of the emittance of a pulsed electron source with laser-induced electron emission are described. The energy spread of the electrons in the pulse is evaluated by deflection in a static magnetic field. This source is to be used in an electron ring accelerator. (auth)

50199 (LA–4729) PRIMARY BEAM TRANSPORT: EXPERIMENTAL AREA A. Silbar, R. R. (Los Alamos Scientific Lab., N. Mex.). Jul 1971. Contract W-7405-eng-36. 12p. Dep. NTIS.

First-order TRANSPØRT runs for target-to-target transport in the LAMPF experimental area A are described and discussed. (auth)

50200 (SLAC–132) TWO-MILE ACCELERATOR PROJECT. Quarterly Status Report, January 1–March 31, 1971. (Stanford Linear Accelerator Center, Calif.). Jun 1971. Contracts AT-(04-3)-400; AT(04-3)-515. 64p. Dep. NTIS.

A status report on the Stanford Linear Accelerator Project covering the period January 1, 1971 to March 31, 1971 is presented. Topics included are accelerator and research area operations, accelerator and research area equipment development, and physics research equipment development. (auth)

50201 (UCRL–73146) LIVERMORE HIGH INTENSITY ELECTRON STORAGE RING. Beal, J. W.; Cooper, R. K.; Lamb, W. A. S.; Neil, V. K.; Smith, L. (California Univ., Livermore. Lawrence Radiation Lab.). 12 Jul 1971. 10p. (CONF-710908–1). Dep. NTIS.

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

A high intensity electron storage ring is being constructed at Lawrence Laboratory Livermore. The purpose of this device is the study of the effects of electromagnetic self-forces at beam currents up to 1000 A and energies up to 6 MeV. In the initial stage of operation no rf cavity will be used. A lifetime of at least a few milliseconds is contemplated, and the design is such that at peak current the negative mass and resistive wall instabilities are expected to occur within this time. The effect of various inductive structures on longitudinal stability will be investigated. Experimental studies will be made to elucidate the phenomena associated with transverse beam stability. The ring has a circumference of 28.8 m. The aluminum vacuum tank has a circular cross section of 2 ft in diameter. Air core magnets provide the magnetic fields of the eight section FDO lattice. The quadrupole doublet and the zero gradient bending magnets are separately powered, but superimposed in space. To facilitate study of resonance effects, Q-values between 1.5 and 2.5 are obtainable. (auth)

50202 (UCRL-Trans–1446) CHARGED RELATIVISTIC ELECTRON RINGS IN A HELICAL MAGNETIC FIELD. Bonch-Osmolovskii, A. G. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by G. Brodell and L. J. Laslett for Univ. of California Lawrence Radiation Lab., Berkeley, from report JINR–P9-5299. 21p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 25: 5448. (M.O.W.)

50203 PREPARATION OF OXYGEN TARGETS FOR POSITIVE ION ACCELERATORS. Chakraborty, P.; Sargent, B. W.;

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Montague, J. H. (Queen's Univ., Kingston, Ont.). Nucl. Instrum. Methods; 95: No. 2, 209-11(1971).

A simple technique is described for preparing thin targets of oxygen as copper oxide on thick copper backings, suitable for experiments with low-energy positive-ion accelerators. The copper blanks are thoroughly cleaned with nitric acid solutions and then baked in a hydrogen atmosphere. The oxidation of the copper takes place at a suitable temperature and pressure in oxygen gas. The process is terminated when the color of the oxide film indicates that the desired thickness has been reached. Since the gas volume is kept small, this method is particularly suitable for making targets of costly ^{18}O and ^{17}O isotopes. (auth)

50204 STUDY OF DEUTERIUM IMPLANTATION IN A COPPER DRIVE-IN TARGET. Bartle, C. M.; Chapman, N. G.; Johnson, P. B. (Victoria Univ., Wellington, N. Z.). Nucl. Instrum. Methods; 95: No. 2, 221-8(1971).

The associated-particle technique is employed in conjunction with the $D(d,n)^3He$ reaction to study the distribution of implanted deuterium within the surface of a metal drive-in target. Changes that occur in the tagged neutron beam profile measured in the reaction plane are interpreted in terms of a changing deuterium distribution in the target. A simple model that predicts the results is presented. (auth)

50205 LOW COST MULTI-PURPOSE TARGET CHAMBER. Feldl, E. J.; Eck, J. S. (Kansas State Univ., Manhattan). Nucl. Instrum. Methods; 95: No. 2, 233-5(1971).

The characteristics and specifications of a 10 in. (25.4 cm) diameter, highly versatile target chamber are presented. Designed to be an inexpensive multipurpose chamber, it facilitates measurement of $\gamma-\gamma$, γ-particle, and $\gamma-\gamma$-particle correlations, angular distributions of both particles and γ rays, perturbed angular correlations, and many other experimental parameters. (auth)

50206 SHADOW MEASUREMENTS IN A CYCLOTRON. Schreuder, H. W. (Technological Univ., Delft, Netherlands). Nucl. Instrum. Methods; 95: No. 2, 237-44(1971).

The connection between shadow measurements on a cyclotron beam and the concepts of coherent and incoherent radial betatron oscillation is studied. Conditions for the determination of the amplitude of the coherent oscillation from shadow measurements are discussed, and the influence of a coherent oscillation on the shadowwidth is investigated. Finally, the maximal and minimal shadowwidths are calculated for a beam with an elliptical emittance, in the case of zero amplitude of the coherent oscillation. (auth)

50207 NOMOGRAM FOR MAGNETIC QUADRUPOLE DOUBLETS. Figueiredo Dias, M. G.; Da Silva, C. M. (Laboratorio de Fisica e Engenharia Nucleares, Sacavem, Portugal). Nucl. Instrum. Methods; 95: No. 2, 265-7(1971).

The present nomogram allows a first-order calculation of the focusing properties of a quadrupole doublet under the assumption that the thin-lens approximation applies. Magnifications, focal lengths and image distance are obtained. (auth)

50208 CALCULATION OF THE LONG-LIVED ACTIVITY IN SOIL PRODUCED BY 500-GeV PROTONS. Gabriel, T. A.; Santoro, R. T. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods; 95: No. 2, 275-83(1971).

Calculations are made to estimate the time and spatial dependence of the long-lived ($\tau_{\frac{1}{2}} \geq 1$ d) activity in the soil surrounding a semi-infinite beam target tunnel. The activity distributions are given for 500-GeV protons incident on a Be target positioned in the tunnel for an irradiation time of 25 y at 10^{13} protons per second and at a time after shutdown of one month. The distributions are presented as a function of the radial distance from the tunnel axis for the spatial regions along the tunnel and at the end of the tunnel. The activity arising from selected nuclides is given for selected spatial points. Curves showing the decrease in activity as a function of shutdown time are given. Included is the calculated integrated activity along the tunnel axis. (auth)

50209 MEASUREMENT OF THE DUTY CYCLE OF THE BEAM OF A SYNCHROCYCLOTRON. Deschamps, J.; Hrisoho, A. (Institut de Physique Nucleaire, Orsay, France). Nucl. Instrum. Methods; 95: No. 2, 385-7(1971). (In French).

A simple digital method for measuring the "duty cycle" of the beam of a synchrocyclotron is described. Within a given range, the measurement obtained with this equipment does not depend on the intensity of the beam or the dead time of the shaping circuits. (auth)

50210 EXISTENCE OF DOUBLY NEGATIVE CHARGED HEAVY IONS. Baumann, H.; Heinicke, E.; Kaiser, H. J.; Bethge, K. (Univ., Heidelberg). Nucl. Instrum. Methods; 95: No. 2, 389-91(1971).

In former investigations for the production of negative ions with a Penning source, some peaks corresponding to a mass half of that of the negative ion X^- have appeared in the mass spectra. The electric and magnetic deflection of these ion beams showed that these beams are composed, in particular, of doubly charged negative ions. Beam intensities of O^{--}, Te^{--}, Bi^{--}, F^{--}, Cl^{--}, Br^{--}, and I^{--} were measured to be on the order of 0.2 to 2 nA. (auth)

50211 RING ACCELERATOR HAVING A MONOENERGETIC BEAM. Koshkarev, D. G. (Inst. of Theoretical and Experimental Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 6, 1555-6(Nov-Dec 1970).

Translated from Prib. Tekh. Eksp.; No. 6, 13-14(Nov-Dec 1970).

The possibility of creating a ring accelerator having an almost monoenergetic beam of charged particles at its output is discussed. The energy scatter in the extracted beam does not exceed $\pm 1 \cdot 10^{-4}$ for an average beam current of several microamperes. (auth)

50212 HIGH-CURRENT PULSED ELECTRON ACCELERATOR. Bugaev, S. P.; El'chaninov, A. S.; Zagulov, F. Ya.; Koval'chuk, B. M.; Mesyats, G. A. (Inst. of Atmospheric Optics, Tomsk, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 6, 1557-9(Nov-Dec 1970).

Translated from Prib. Tekh. Eksp.; No. 6, 15-17(Nov-Dec 1970).

The construction and operation of a straight-line accelerator with E = 500 keV, $I = 10^4$ A, and $\tau_i = 25$ nsec is reported. The storage element of the accelerator is charged through a pulse transformer. The latter has an open core when a coaxial type transformer is used. A coaxial line filled with glycerin is used as the storage element. The wave impedance of the line is 8 Ω, and its electrical length is 25 nsec. Charge time of the storage line is 0.5 μsec. A gas discharge under pressure is used for commutating, and a plasma cathode serves as the electron emitter. (auth)

50213 SHORT-CIRCUITING DEVICE OF THE RESONANCE LINE OF A CYCLOTRON DEE CIRCUIT. Krasnov, N. N.; Alekseev, E. N. (Physics and Power Inst., Obninsk, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 6, 1564-6(Nov-Dec 1970).

Translated from Prib. Tekh. Eksp.; No. 6, 20-2(Nov-Dec 1970).

A short-circuiting device for the resonance line of a cyclotron dee circuit in which the contact cams are pressed by elastic rings which are squeezed by the difference between the outside pressure and the pressure inside the cyclotron chamber is described. (auth)

50214 BEAM MONITORING BY RECORDING SCATTERED PARTICLES. Sirotonin, E. I.; Fiderkevich, A.; Shishkin, K. S.; Karandashov, V. G. Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 6, 1567-8(Nov-Dec 1970).

Translated from Prib. Tekh. Eksp.; No. 6, 22-3(Nov-Dec 1970).

A method of monitoring a beam of charged particles by recording particles scattered by a baffle periodically covering the beam is described. The scattered particles are recorded by a semiconductor detector. (auth)

50215 HIGH-PRESSURE GAS TARGET WITH NITROGEN COOLING. Denisov, S. P.; Nekrasov, A. N.; Stoyanova, D. A. (Inst. of High-Energy Physics, Serpukhov, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 6, 1569-71(Nov-Dec 1970).

Translated from Prib. Tekh. Eksp.; No. 6, 24-6(Nov-Dec 1970).

A 3-m gas target is described for operation with H_2, D_2, and He at pressures up to 75 atm and T ≈ 78°K, used in experiments on particle beams of the 70-GeV accelerator at the Institute of High-Energy Physics, Serpukhov. The total thickness of gas which can be achieved in this target is ~7.5 g/cm² for H_2, ~15 g/cm² for D_2, and ~13 g/cm² for He. The accuracy of measurement of the total thickness is 0.5% for H_2 and He and ~0.7% for D_2. The total thickness of the window for the beam of particles is 2 g/cm². (auth)

50216 PION BEAM FOR THE 2-m ITEF LIQUID-HYDROGEN BUBBLE CHAMBER. Aleshin, Yu. D.; Arutyunyants, G. A.; Verebryusov, V. S.; (and others). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 6, 1578-80(Nov-Dec 1970).

Translated from Prib. Tekh. Eksp.; No. 6, 31-3(Nov-Dec 1970).

The pion beam with a momentum of 3 to 5.2 GeV/c from the IT ÉF proton synchrotron for the 2-m liquid-hydrogen bubble chamber is described. (auth)

50217 AUTOMATIC PHASE CONTROL OF A CYCLOTRON DEFLECTING VOLTAGE. Biryukov, N. S.; Zhuravlev, B. V.; Plaskin, V. I.; Sal'nikov, O. A. (Physics and Power Inst., Obninsk, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 6, 1664-6(Nov-Dec 1970).

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Translated from Prib. Tekh. Eksp.; No. 6, 105-7(Nov-Dec 1970).

A circuit for automatic phase control of the deflecting voltage in a system for reducing the repetition frequency of charged-particle bunches in a cyclotron with low-frequency beam modulation is described. The sensitivity to a phase change is at least 1°. The block diagram and schematic of the circuit are given. (auth)

50218 AUTOMATIC CONTROL OF STABILITY OF HEAVY-CURRENT SUPPLIES. Omel'chenko, B. D. (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 6, 1730-2(Nov-Dec 1970).

Translated from Prib. Tekh. Eksp.; No. 6, 159-62(Nov-Dec 1970).

An automatic control system for the stability of heavy direct-current supplies used for feeding the magnetic elements of the channels for charged particle transportation is described. The system envisages the use of a coherer stepping switch (selector) and ensures stability control to an accuracy of ±0.05 to 0.1%. (auth)

50219 DETERMINATION OF THE INTENSITY OF A BEAM OF DEUTERONS EXTRACTED FROM A SYNCHROTRON AND MEASUREMENT OF THE CROSS SECTIONS FOR THE $^{12}C(d,p2n)^{11}C$ AND $^{27}Al(d,3p2n)^{24}Na$ REACTIONS AT 2.33 GeV. Banaigs, J. (CNRS, Saclay, France); Berger, J.; Duflo, J.; (and others). Nucl. Instrum. Methods; 95: No. 2, 307-11(1971). (In French).

A device that integrates the Cherenkov light produced in a solid radiator is used to measure the intensity of a 3.76-GeV/c deuteron beam extracted from the synchrotron Saturne. This device is calibrated by a proton beam that has the same velocity as the deuteron beam and, therefore, produces the same Cherenkov light. The intensity of the equivalent proton beam is measured by irradiating thin carbon and aluminum targets. The deuteron beam thus calibrated permits the measurement of cross sections for the reactions $^{12}C(d,p2n)^{11}C$ and $^{27}Al(d,3p2n)^{24}Na$. (auth)

50220 LINEAR ACCELERATORS. Lapostolle, Pierre M.; Septier, Albert L. (eds.). Amsterdam; North-Holland Publishing Company (1970). 1225p. $61.00.

The book is divided into five parts: introduction, electron linear accelerators, proton linear accelerators, heavy ion linear accelerators, and superconducting linear accelerators. Each part is subdivided into different chapters covering various topics. Separate abstracts were prepared for the 46 chapters presented. (France)

For abstracts of individual chapters see: 49841 and 50221–50265.

50221 HISTORY OF LINEAR ACCELERATORS. Blewett, J. P. (Brookhaven National Lab., Upton, N. Y.). pp 1-18 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The definition and basic principles of linear accelerators are discussed and a chronological history of their development presented. A discussion is given on the early accelerator, postwar developments, the Stanford Linear Accelerator, and other electron accelerators. The 32 MeV Berkeley proton linear accelerator, other proton accelerators, heavy ion linear accelerators, and high average current linear accelerators are mentioned. Recent developments and the literature available are discussed. (France)

50222 GENERAL THEORY OF LINEAR ACCELERATORS. Hereward, H. G. (CERN, Geneva). pp 19-37 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The general theory of linear accelerators is discussed and the most important features underlined. These features include phase stability, transverse defocusing, properties of the travelling wave, longitudinal motion, Liouville's theorem and adiabatic processes, r-f power considerations, electron linac structures (periodic structures), and proton linac structures. (France)

50223 ACCELERATING STRUCTURES. Loew, G. A.; Neal, R. B. (Stanford Linear Accelerator Center, Calif.). pp 39-113 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

An introduction is given to the theory and design of accelerating structures. The principles behind periodic loading, the design parameters, travelling wave accelerators, and standing wave accelerators are given. Superconducting accelerators are discussed. Analytical and computer techniques used in structure design are presented and empirical design methods are discussed. A summary is given of the characteristics of the accelerating structures of existing linacs. (France)

50224 PARTICLE DYNAMICS. Helm, R. H.; Miller, R. (Stanford Linear Accelerator Center, Calif.). pp 115-46 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The properties of electron linear accelerators are contrasted against those of proton linear accelerators. The following topics are then discussed: injection dynamics, including a general philosophy of buncher design, gun optics, prebunching, longitudinal and transverse motion in the capture region, and focusing; asymptotic high energy dynamics; external focusing requirements for high energy transport, especially in very long machines; and transverse perturbing effects such as misalignment and stray magnetic fields. Also scattering due to the residual gas in the accelerator is briefly discussed. (France)

50225 BEAM LOADING AND TRANSIENT BEHAVIOR IN TRAVELING WAVE ELECTRON LINEAR ACCELERATORS. Leiss, J. E. (National Bureau of Standards, Washington, D. C.). pp 147-72 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The meaning of beam loading and its importance in linear accelerators are discussed. The nature of the problem and the necessary assumptions which have to be made are presented. A theory of beam loading based upon the diffusion equation is enumerated. Further theory is given on beam loading including dispersion effects. (France)

50226 BEAM BREAKUP. Helm, R. H.; Loew, G. A. (Stanford Linear Accelerator Center, Calif.). pp 173-221 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The phenomena of beam breakup is introduced. Physical manifestations and models are described. Regenerative beam breakup and multisection or cumulative beam breakup are dealt with in detail. Other electromagnetic instabilities encountered in linacs are discussed. (France)

50227 PROBLEMS CONNECTED WITH THE MEASUREMENT OF ACCELERATED ELECTRON BEAM CHARACTERISTICS. Bergere, R. (CEN de Saclay, Gif-sur-Yvette, France). pp 223-35 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

A tentative classification of methods of measurement is given. The time frequency characteristics associated with perturbation methods are discussed as are the beam characteristics associated with different lobes of frequency. A discussion is given on the quantity of information contained in a single measurement. (France)

50228 ELECTRON INJECTORS. Brunet, P.; Buffet, X. (Paris Univ., Orsay, France). pp 237-64 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

A definition of an electron injector is given and some of the principal characteristics presented. The choice of parameters and the sub-assemblies are described. Methods for measuring the characteristics of the injector are presented and examples of injector assemblies given. (France)

50229 ACCELERATING STRUCTURES TECHNOLOGY. Eldredge, A. L.; Lisin, A. V.; Price, V. G. (Stanford Linear Accelerator Center, Calif.). pp 265-313 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

An introduction is given emphasizing the importance of design and materials. The very high precision necessary in the construction and fabrication processes is elaborated. Fabrication methods are described and the microwave tuning methods adopted are presented. Cooling, temperature control, and the support structures are also described. (France)

50230 RADIOFREQUENCY PROBLEMS. Hogg, H.; Lebacqz, J. V. (Stanford Linear Accelerator Center, Calif.). pp 315-54 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

A general discussion is given on power requirements, types of r-f source and power amplifiers, r-f stability considerations, phasing requirements, and phasing systems currently used. Some specialized problems associated with low, medium, and high energy machines are dealt with and the solutions adopted for some of these machines are given. (France)

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50231 INSTALLATIONS AND CONTROL. Burnod, N. (Paris Univ., Orsay, France). pp 355-83 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amstersam; North-Holland Publishing Co. (1970).

The installations associated with a linear electron accelerator and their controls are defined. Some general characteristics of the building and radiation protection facilities are given. The principal auxiliary equipment and the adjustment and control systems are described. (France)

50232 USE OF HIGH ENERGY ELECTRON LINEAR ACCELERATORS. Ballam, J. (Stanford Linear Accelerator Center, Calif.). pp 385-413 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The four existing high energy electron linear accelerators are presented and the principal experiments for which they are used are mentioned. The following topics are discussed: the concept of form factors, achievements in medium energy physics, the unsuspected potentialities of very high energy linacs, positron acceleration and annihilation beams, high energy muon beams, secondary beams, neutral K particles of high energy, radiofrequency separated beams, characteristics of high energy electron linacs in relation to experimental problems, and the use of detection apparatus at high energy electron linear accelerators. A review on the achievements made in high energy physics is given. (France)

50233 HIGH DUTY FACTOR ELECTRON LINEAR ACCELERATORS. Haimson, J. (Massachusetts Inst. of Tech., Cambridge). pp 415-70 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The necessity of having high duty factors with high energy electron accelerators is discussed along with the means whereby they are achieved. The topics covered include: general design considerations, principal design parameters, the r-f system, accelerator waveguides, and the injection system. (France)

50234 LOW ENERGY, HIGH INTENSITY ELECTRON ACCELERATORS. Leboutet, H. (Centre de Recherches Thomson-CSF, Orsay, France). pp 471-93 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1971).

Small electron linacs with high intensity outputs are discussed. Although similar in principle to high energy accelerators, specific problems are encountered in the design of windows and targets. The topics covered include: radiation chemistry, radiography, flash radiography, stroboscopic radiography and radiotherapy. (auth)

50235 LINEAR ACCELERATORS AS INJECTORS FOR CYCLIC MACHINES. Crowley-Milling, M. C. (Daresbury Nuclear Physics Lab., Eng.). pp 495-522 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

An introduction is given describing the use of linear accelerators as injectors for cyclic machines. Electron synchrotrons now use linear accelerators as injectors. The following topics are dealt with: the production of a narrow energy spectrum, effects of variations of the parameters, emittance, beam loading effects in the synchrotron, and debunching systems. Examples of electron synchrotron injectors and of positron injection are given. (France)

50236 POSITRON ACCELERATORS. Amman, F. (CNEN, Frascati, Italy). pp 523-51 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

A brief introduction to the use of positron accelerators is given. The topics covered include some general remarks on positron linear accelerators, positron yields, focusing systems, matching systems, the dephasing of positrons in the matching and focusing systems, the converter, positron acceleration and some experimental results. (France)

50237 RACETRACK MICROTRON: AN ELECTRON ACCELERATOR FOR MEDIUM ENERGIES. Wiik, B. H.; Wilson, P. B. (Stanford Univ., Calif.). pp 553-67 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The racetrack microtron is described and the advantages it offers over certain other machines are mentioned. The operation principles and some details about the design are given. (France)

50238 RADIOFREQUENCY SEPARATORS. Montague, B. W. (CERN, Geneva). pp 569-83 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

After mentioning some historical aspects of radiofrequency separators, the basic principles are discussed. The separators of Panofsky and Schnell are described. A description is then given of deflecting waves and structures, separator optics, engineering aspects, and the present status and future developments envisaged. (France)

50239 LOW AND MEDIUM ENERGIES, ALVAREZ STRUCTURES. Carne, A. (Rutherford High Energy Lab., Chilton, Eng.). pp 587-600 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

A brief introduction mentioning the properties of different types of structures and the advantages of Alvarez structures is given. The Alvarez structure is then discussed in detail. The tolerances necessary and the effect of individual cell tuning errors are presented. A discussion on the optimization is given. (France)

50240 HIGH ENERGY STRUCTURES. Knapp, E. A. (Los Alamos Scientific Lab., N. Mex.). pp 601-16 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The problems encountered with drift tube type structures at high energies are discussed. The π mode type operation is mentioned and the advantages offered by $(\pi/2)$ mode operation presented. Specific properties of the $(\pi/2)$ mode in a periodic system are discussed. The side coupled accelerator structure is described in detail. (France)

50241 NUMERICAL COMPUTATION OF FIELD DISTRIBUTIONS. Katz, A. (CEN, Saclay, France). pp 617-36 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

Different approaches used to compute the field distributions and electrical parameters of a linac Alvarez type cell are briefly mentioned. Modern methods of treating the problem are discussed. The following topics are covered: mathematical formulations, discretization of the partial derivative equation, an expression for the boundary conditions, the diagonal dominance of the A matrix, error evaluation, the convergence rate, external improvements of convergence rate, and the calculation of electrical parameters. (France)

50242 REVIEW AND SURVEY OF ACCELERATING STRUCTURES. Dome, G. (CERN, Geneva). pp 637-738 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The shunt impedance and transit time factor are defined. A comparison is made between travelling wave and standing wave operation. Structures with resonant coupling and non-resonant coupling are discussed, and the shunt impedance of different structures are compared. (France)

50243 INTRODUCTION. Lapostolle, P. (CERN, Geneva). pp 739-45 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The difference between proton and electron linac dynamics are emphasized and the step by step method of computation used in the design and analysis of proton linear accelerators is discussed. Structure design, field law, phase law, buncher, and debuncher are described. (France)

50244 NUMERICAL METHODS. ACCELERATION BY A GAP. Carne, A. (Rutherford High Energy Lab., Chilton, Eng.); Lapostolle, P.; Schnizer, B.; Prome, M. pp 747-83 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The elements of the matrix describing the influence of the field of an accelerating gap on the dynamical variables of a single proton crossing it are described. The following topics are covered: field representations, series expansion of the fields, voltage transit time factor and other beam dynamics coefficients, motion of a proton in a spatially homogeneous time-harmonic field, the perturbation parameter K, general considerations on perturbation theory, the thin lens approximation, derivation of nonrelativistic difference equations for energy, phase, radial position and velocity across a gap, nonrelativistic difference equations for the change of the dynamical quantities in the first half of a gap, relativistic corrections, and applications to linac design and computation. (France)

50245 FOCUSING. Prome, M. (CEA, Saclay, France). pp 785-96 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The need for focusing is explained. The elements of the periodic structure theory, stability diagrams, and high energy focusing considerations, are presented. (France)

50246 NONLINEAR EFFECTS. Gluckstern, R. L. (Univ. of Massachusetts, Amherst). pp 797-804 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

Some general considerations are discussed, and the following topics considered: longitudinal phase acceptance, coupling between longitudinal and transverse oscillations, coupling between the two transverse oscillations, misalignment and errors, misalignment and couplings, and effects of space charge. (France)

50247 INTRODUCTION. Lapostolle, P. (CERN, Geneva). pp 805-7 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

High intensity effects in linear accelerators are discussed: beam loading, transients, space charge effects, and beam break up. (France)

50248 TRANSIENTS AND BEAM LOADING EFFECT. Nishikawa, T. (Tokyo Univ.). pp 809-26 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The various methods of analysis are discussed. The following topics are covered: transients calculation using the cylindrical waveguide model, normal mode analysis, results and comparisons with measurements, field induced by the beam, effects of beam loading, and methods for improvements. (France)

50249 SPACE CHARGE EFFECTS. Gluckstern, R. L. (Univ. of Massachusetts, Amherst). pp 827-36 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The effects of space charge are described and the theory of longitudinal and transverse space charge effects discussed. Self consistent models, numerical models, and the limitations of the simple analytic considerations and numerical computations carried out up to now are discussed. (France)

50250 PRE-INJECTORS. Huguenin, J.; Vosicki, B. (CERN, Geneva). pp 837-78 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The function of the pre-injector in the linac is described. The ion sources, optics, and the accelerating tube are described. (France)

50251 ALVAREZ STRUCTURE. Taylor, C. S. (CERN, Geneva). pp 879-95 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The general properties of the Alvarez structure are outlined. The lay-out and a brief description of the operating principles are given. The tolerances and electrical requirements are discussed, and some actual structures presented. The bunching and debunching principles used are described. (France)

50252 HIGH ENERGY STRUCTURES, FABRICATION, AND TUNING. Knapp, E. A. (Los Alamos Scientific Lab., N. Mex.). pp 897-903 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The specialized procedures developed for the fabrication of side coupled accelerator structures are discussed. The design parameters and the construction are described and the method of tuning is given. (France)

50253 RADIOFREQUENCY PROBLEMS. Taylor, C. S. (CERN, Geneva). pp 905-33 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The importance of having efficient accelerating structures (high Q) is emphasized. The resonant load presented by the accelerating structure is discussed. The power source; the coupled system, which includes the amplifier and accelerating cavity; and the controls and instrumentation are described. (France)

50254 BEAM MONITORING, ACCELERATOR SHIELDING, AND SERVICES. Van Steenbergen, A. (Brookhaven National Lab., Upton, N. Y.). pp 935-69 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The following topics are dealt with: beam monitoring, proton linac sheilding, linac cooling, and vacuum requirements. A typical installation is described. (France)

50255 USE OF COMPUTERS FOR CONTROLS. Butler, H. (Los Alamos Scientific Lab., Los Alamos, N. Mex.). pp 971-6 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The use of small digital computers in accelerator control systems is briefly described. The tasks performed by the computer, its limitations, and its advantages, are discussed. A survey is made of the applications. (France)

50256 INJECTORS FOR CIRCULAR ACCELERATORS. Lapostolle, P. (CERN, Geneva). pp 977-86 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The topics covered are: general layout of injection, injection devices, required characteristics, typical performances, improvement activities, and injectors for the generation of synchrotrons with several hundred GeV energy. (France)

50257 PROTON LINACS FOR NUCLEAR PHYSICS STUDIES. Dickson, J. M. (Rutherford High Energy Lab., Chilton, Eng.). pp 987-97 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The differences between proton linear accelerators intended to be used for nuclear physics problems and those intended as injectors are pointed out. The two different types of machine are compared. The PLA machine of the Rutherford High Energy Laboratory is described. Beam quality, the way in which a variable energy is obtained, polarized beams, and time of flight detectors are described. The utilization of the accelerator is discussed. (France)

50258 MESON PRODUCTION. Nagle, D. E. (Los Alamos Scientific Lab., N. Mex.). pp 999-1009 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The suitability of high intensity (mean currents between 50 and 1,000 μA) proton linear accelerator with energies in the 500 to 1,000 MeV range for producing mesons has already aroused considerable interest; the Los Alamos linac project is designed to provide an intense source of π and μ mesons for research into nuclear structure and meson physics; this machine is described in detail. (France)

50259 INTENSE NEUTRON GENERATOR. Tunnicliffe, P.; Bartholomew, G. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). pp 1011-24 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The use of proton linear accelerators to produce intense neutron beams is described. The following topics are dealt with: conceptual arrangement of the Chalk River ING project, the accelerator, the targets, and some special features. (France)

50260 POSSIBILITY OF DEUTERON ACCELERATION. Sluyters, Th. (Brookhaven National Lab., Upton, N. Y.); Regler, M. pp 1025-8 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The possibility of accelerating deuterons in proton linacs is considered. Some general considerations are presented, and the use of the CERN Proton Synchrotron linear accelerator for this purpose is described. (France)

50261 SPECIAL PROBLEMS IN HEAVY ION ACCELERATION. Schmelzer, Ch. (Univ., Heidelberg). pp 1029-45 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The recent interest in heavy ion accelerators is discussed. The following topics are covered: beam particle energy requirements, beam properties, ion sources, stripping, and pressure transparency. Principles involved in the acceleration of heavy ions with radiofrequency linear accelerators are presented. (France)

50262 EXISTING AND PROPOSED HEAVY ION LINEAR ACCELERATORS. Boehne, D.; Schmelzer, Ch. (Univ., Heidelberg). pp 1047-71 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The differences between proton and heavy particle accelerators are described; existing and proposed heavy ion machines are discussed. (France)

50263 RADIOFREQUENCY FOCUSING IN HEAVY ION LINEAR ACCELERATORS. Boussard, D. (CERN, Geneva). pp 1073-87 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

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The focusing problems encountered in heavy ion machines are discussed. Two focusing systems are described in detail, grid focusing, and alternating focusing. (France)

50264 THEORY AND DESIGN OF SUPERCONDUCTING ELECTRON LINEAR ACCELERATORS. Wilson, P. B. (Stanford Linear Accelerator Center, Calif.). pp 1107-40 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The advantages offered by superconducting linear accelerators are described. The relevant theory and design principles are given. Limits on the gradient and current, and actual applications to accelerators are discussed. (France)

50265 SUPERCONDUCTING PROTON LINEAR ACCELERATORS AND PARTICLE SEPARATORS. Citron, A.; Schopper, H. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). pp 1141-80 of Linear Accelerators. /Lapostolle, Pierre M. (ed.). Amsterdam; North-Holland Publishing Co. (1970).

The advantages offered by superconducting proton linear accelerators are described. The topics discussed are: the accelerating structure, injection, beam dynamics, beam loading, parameters, design features, cost estimates, and superconducting particle separators. (France)

50266 SOME PRACTICAL APPLICATIONS OF THE OBSERVATION OF THE ^{16}O-DIRECT PROTON CAPTURE REACTION WITH A Ge(Li) DETECTOR. Joy, T.; Barnes, D. G. (Univ. of Manchester, Eng.). Nucl. Instrum. Methods; 95: No. 1, 199-201(1971).

The direct proton capture reaction in ^{16}O is shown to provide a tool for the determination of oxygen distribution in metals, beam energy and energy spread in favorable circumstances. (auth)

50267 IMPROVEMENTS IN THE TRANSMISSION OF A TANDEM ACCELERATOR. Van Der Heide, J. A. (Univ. of Tech., Eindhoven, Netherlands). Nucl. Instrum. Methods: 95: No. 1, 87-92(1971).

First order calculations are given which were carried out to obtain a good optical matching of a polarized ion source to the 12 MeV H.V.E.C. tandem Van de Graaff of the Utrecht State University. Two alternative injection systems are compared with one another and a relative transmission figure is given. The influence of higher order effects may be diminished by relatively simple means. The ion injection energy may be decreased considerably without significant loss in transmission efficiency if this is required for constructional reasons. (auth)

50268 BUTANOL POLARIZED DEUTERON TARGET. I. POLARIZATION AT 25 kOe. Borghini, M.; Scheffler, K. (CERN, Geneva). Nucl. Instrum. Methods; 95: No. 1, 93-8(1971).

Dynamic deuteron polarizations up to 22% were obtained in samples of a few cm^3, made out of perdeuterated 1-butanol and heavy-water mixtures, doped with porphyrexide—a free radical—at temperatures down to 0.5 K, in a magnetic field of 25 kOe. The polarization of the few remaining protons (about 2%) was found to reach 80%. Different ways of calibrating the deuteron polarization, including 600 MeV proton scattering, yielded the same results. (auth)

50269 PERSPECTIVES OF USE OF SOLID HYDROGEN TARGETS FOR PRIMARY BEAMS OF CYCLIC ACCELERATORS AT HIGH ENERGIES. Tolstov, K. D. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Instrum. Methods; 95: No. 1, 99-101(1971).

The expediency of the use of and the possibility of setting up supercooled solid hydrogen targets for primary beams of cyclic accelerators at high energies and large intensities are presented. Such targets will provide for nuclear interactions of the main portion of primary protons. Also they will make possible the investigation of elastic and inelastic p−p and p−d interactions, the increase of intensity of secondary beams, the elimination of target activation, a decrease in the background and the radiation of an accelerator. (auth)

50270 DIFFRACTION RADIATION DEFOCUSING OF AN ELECTRON RING. Keil, E. (CERN, Geneva); Pellegrini, C.; Sessler, A. M. Nucl. Instrum. Methods; 95: No. 1, 131-5(1971).

The influence upon axial stability in an electron ring of the diffraction radiation reaction force, generated by a ring moving in an acceleration column, is calculated theoretically. A stability criterion is obtained, and numerical examples show that the criterion is not an important constraint upon the choice of parameters or the operation of an electron ring accelerator. (auth)

50271 ELECTRONIC STOPPING CROSS SECTIONS OF DEUTERONS IN TITANIUM. Ormrod, J. H. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Instrum. Methods; 95: No. 1, 49-51(1971).

Electronic stopping cross sections of deuterons in titanium were measured from 30−200 keV. Oxidation of the titanium film was eliminated by measuring the energy loss in thin Al−Ti−Al sandwiches. (auth)

50272 DETERMINATION OF TRANSFER TIMES IN AN ON-LINE ISOTOPE SEPARATOR. Winsberg, L. (Soreq Nuclear Research Centre, Yavne, Israel). Nucl. Instrum. Methods; 95: No. 1, 19-22(1971).

The transfer, T_t, is defined as the time from the instant a nuclide is created until it is deposited on the collector of an on-line isotope separator. The distribution, $p(T_t)$, in the values of T_t can be determined from experiments in which the growth in activity of a given nuclide on the collector is measured as a function of the time after beginning the irradiation of the target. This distribution is needed for determining cross-section values, fission yields, and genetic relationships of short-lived nuclides. (auth)

50273 DETERMINATION OF CROSS SECTIONS WITH AN ON-LINE ISOTOPE SEPARATOR. Winsberg, L. (Soreq Nuclear Research Centre, Yavne, Israel). Nucl. Instrum. Methods; 95: No. 1, 23-7(1971).

In an on-line isotope separator there may be appreciable decay of short-lived nuclides during the time of transit T_t to the collector. From the measured activity on the collector as a function of time and from the distribution $p(T_t)$ in the values of T_t, it is possible to determine cross-section values for forming products of nuclear reactions that take place in the target. (auth)

50274 PROCEEDINGS OF THE 1971 PARTICLE ACCELERATOR CONFERENCE, CHICAGO, ILLINOIS, MARCH 1–3, 1971. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1-1161(Jun 1971). (CONF-710308).

Separate abstracts were prepared for 312 of the 336 papers presented. The remaining 24 papers were previously included in NSA. For abstracts of these 24 papers see CONF-710308 in a cumulative report number index. (W.H.K.)

For abstracts of individual papers see: 48934, 49007, 49053, 49054, 49070−49072, 49265, 49853−49857, 50042, 50275−50571, and 50701.

50275 RELEVANCE OF PARTICLE ACCELERATORS TO NATIONAL GOALS. Rosen, Louis (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 29-35(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The relationship of particle accelerators to national goals is discussed, and the world-wide inventory of accelerators is reviewed. The role of particle accelerators in industry, nondestructive testing, radioisotope production, power reactor applications, radiation processing, the role of accelerators in defense, and particle accelerators for medical purposes are discussed. (W.H.K.)

50276 FEDERAL FUNDING OF PHYSICS: PROSPECTS AND POLICY. Donovan, Paul F. (National Science Foundation, Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 46-54(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Graphs and charts that indicate the trends in federal funding of physics research are presented and discussed. National Science Foundation (NSF) budget program comparisons and budget allocations for FY 1970−1972 are itemized and discussed. (W.H.K.)

50277 HIGH CHARGE STATE HEAVY ION SOURCES. Bennet, J. R. J. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 55-62(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A review is given of existing sources of highly charged heavy ions. The performance of the sources, predominantly of the P.I.G. type, is summarized and compared. Some mechanisms for the production of high charge states are described. There is a brief description of new developments, particularly of devices using ion trapping. (auth)

50278 TRANSIENTS IN LARGE TANDEM ACCELERATORS. Rose, P. H. (High Voltage Engineering Corp., Burlington, Mass.);

Milde, H. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 63-7(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The stored energy in dc accelerators capable of reaching terminal potentials of 30 or 40 MV is more than an order of magnitude greater than in existing machines. To analyze the concentration of electrical fields under surge conditions the accelerator has been modeled by lumped constant networks. The analysis shows that in structures similar to the present ones the voltage distribution during a surge is very uneven and micro-discharges in the tube can initiate complete accelerator collapse. (auth)

50279 PERFORMANCE CHARACTERISTICS OF THE 30 MeV THREE-STAGE TANDEM FACILITY AT BNL. Wegner, H. E. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 68-70(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The 30 MeV 3-stage Van de Graaff facility at Brookhaven National Laboratory achieved the desired operating specifications on July 28, 1970 and has been in operation on various research programs since. The facility consists of two MP Tandem Van de Graaff accelerators arranged in line with a negative ion source installed in the terminal of the first accelerator. The two accelerators can either be used as separate Tandem accelerators or together in a 3-stage configuration. Proton energies as high as 30.5 MeV with currents as high as 4 microamperes have been obtained. (auth)

50280 PELLETRON ACCELERATOR. Herb, R. G. (National Electrostatics Corp., Middleton, Wis.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 71-5(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A review is given of early development work at the University of Wisconsin on electrostatic accelerators insulated by high pressure gas. This work started in 1933 and led in 1940 to a 4.5 MeV accelerator. A three-stage accelerator was built and was tested with a beam up to energies of 22 MeV. A two-stage accelerator to provide 28 MeV protons (14 MV on terminal) is under construction. A two-stage accelerator to give 40 MeV protons (20 MV on terminal) has been designed. (auth)

50281 PRODUCTION OF THE ULTRA-HIGH CHARGE STATES IN HEAVY-ION COLLISIONS. Wittkower, A. B.; Ryding, G.; Rose, P. H. (High Voltage Engineering Corp., Burlington, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 76-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Charge state fractions have been determined for iodine, selenium and bromine ions traversing oxygen, argon, krypton, xenon, carbon foil and gold foil targets. Particular attention has been paid to high charge states, some containing as little as 10^{-6}% of the primary beam intensity. Despite the fact that heavy gas targets produce a low mean charge they were found to be more efficient producers of very high charge states than lighter targets. For the very highest charge states recorded (>22^+ for iodine ions at 12 MeV), the heaviest gas target, Xe, produced even more of these ions than a carbon foil. The results showed that ^{82}Se ions at 400 MeV could be obtained from a TU tandem, using only a single gas stripper in the terminal, with an intensity greater than 10^8 particles/sec. Measurements of the attenuation cross sections and scattering of the ultra-high charge states were also made. Typical values for iodine beams at 16 MeV in air are $\sigma_a \sim 5.10^{-15}$ cm^2/molecule for charge states 13^+ to 22^+, with scattering angles (F.W.H.M.) in the order of 10 milliradians. (auth)

50282 PERFORMANCE OF ANL 4-MV DYNAMITRON WITH HEAVY-ION SOURCE. Taylor, A. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 79-81(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The performance of the ANL 4-MV Dynamitron accelerator using a Danfysik heavy-ion source is briefly described. Using CCl_4 support gas, 2 μA beams of $^{58}Ni^+$ were obtained at 3.5 MeV and 6 μA beams at 2 MeV by optimizing source chemistry. (auth)

50283 NEW 5 MeV ELECTROSTATIC ION ACCELERATOR AT THE CENTRAL RESEARCH INSTITUTE FOR PHYSICS, BUDAPEST, HUNGARY. Pasztor, E.; Kostka, P.; Klopfer, E. (Central Research Inst. for Physics, Budapest). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 82-4(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The new 5 MeV Van de Graaff ion accelerator is described, which has been projected, built, tested and manufactured at the Central Research Institute for Physics in Budapest, with some necessary aid from Hungarian industry (pressure vessel etc.). The description and main data of the accelerator are given and the experience with the accelerating tubes is detailed. As a result of several steps in development and careful design, the intensity of X-ray radiation could be reduced in the region of 4 to 5 MV by 2 or 3 orders of magnitude. On the outer surface of the generator vessel at 4 to 5 MV there is measured (without ion beam) only 3 to 5 times the intensity of the natural radiation background, max. 0,5 mR/h. The intensity with an accelerated ion beam is also very low. During a 5 month period in 1970 the generator was operated 2650 hours for measurements in nuclear physics. (auth)

50284 HEAVY ION SOURCE WITH PULSED MAGNETIC FIELD. Isaila, M.; Prelec, K. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 85-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A compact P.I.G. ion source with pulsed field and end extraction is described. The source produces multiply ionized N, C, Ne, A, Kr and Xe. Pulsed currents of C^{3+}, N^{3+}, Ne^{3+}, A^{3+}, Kr^{3+}, Xe^{6+} between a few tens and a few hundreds of μA have been obtained. Small size and power consumption make it compatible with a Van de Graaff terminal where space and power are at a premium. (auth)

50285 PREINJECTOR OF THE BNL 200 MeV LINEAR ACCELERATOR. Kovarik, V. J.; Lankshear, R. F.; Sluyters, Th. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 87-9(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The 850 kV high gradient preinjector is an improved version of the preinjector built for the 50-MeV linac. A new construction technique allows for replacement of tube sections. It is virtually arc-free despite its open structure. It does not need conditioning time mainly due to the all titanium inner structure and the clean ion sputter pumps. Beam intensities up to 500 mA have been accelerated. For routine beams of 400 mA and 100 μsec pulse length the normalized emittance area measured at 800 keV is 1.4 cm-mrad. (auth)

50286 PULSED-BEAM TECHNIQUES USED WITH A TANDEM VAN DE GRAAFF ACCELERATOR. Bernard, D. L. (Univ. of Texas, Austin); Morgan, I. L.; Peoples, J.; Perrine, B. V.; Taylor, M. C. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 90-1(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A pulsed-beam ion source injector was installed on the University of Texas Tandem Accelerator. The injector consists of a direct extraction negative ion source coupled to a 100 keV Cockroft–Walton accelerator. Improvements in the arrangement and fabrication of the high voltage components of the injector are discussed. R. F. pulsing and klystron bunching of the ion beam is done before entering the tandem and a simple, inexpensive method of rejecting the retrace component of the pulsed beam is presented. Pertinent pulsed beam characteristics measured under fast neutron time-of-flight experimental conditions are given. (auth)

50287 HIGH POWER COCKCROFT–WALTON GENERATOR. Reinhold, G.; Truempy, K.; Gleyvod, R. (Emile Haefely and Co., Ltd., Basel). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 92-3(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

To utilize the full current capability of the simple or symmetrical cascade generator, the conventional selenium rectifiers have to be replaced by a series-connection of silicon diodes which are rather sensitive to overvoltages and overcurrents. The problem of the application and protection of silicon diodes in high voltage generators had to be overcome in connection with the design of an air-insulated 770-kV dc power supply with a rated current of 180 mA dc for the Atomic Energy of Canada, Ltd., Chalk River, Ontario. The frequency converter set and the high voltage transformers are over-rated to allow the future extension of the rectifier stack to 1 megavolt. The high voltage dc power supply is

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operated at 10 kc/s to achieve a voltage stability and ripple of less than 1 part in 1000. The equipment was installed at Chalk River in 1970 and will be used as an injector or preaccelerator power supply. For a 600-keV electron accelerator with a total beam current of 100 mA, silicon rectifiers were developed which can be used in pressurized high voltage dc power supplies. (auth)

50288 DESIGN AND PERFORMANCE CHARACTERISTICS OF THE ZERO GRADIENT SYNCHROTRON (ZGS) H^- ION SOURCE AND RELATED SYSTEMS. Fasolo, J. A.; Marmer, G. J.; Moenich, J. S. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 94-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

An expression for the maximum H^- current obtainable from an H^+ beam by charge exchange in hydrogen has served as a guide in the design and development of a source of H^- ions for booster injection into the ZGS. It is used as a criterion in the evaluation of test-bench results obtained with the present test source. Space and power limitations in the 750-keV terminal of the preinjector have led to the use of titanium sublimation pumping to handle large instantaneous gas loads. Power limitations and the need for high pumping conductance have led to the substitution of electrostatic deflection for magnetic deflection in the beam separator. (auth)

50289 3-MV INJECTOR FOR THE SUPERHILAC. Spence, D. A.; Gavin, B. F.; Peters, R.; (and others) (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 97-101(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A pressurized high voltage generator has been constructed to accelerate particles with charge-to-mass ratios between .042 and .09, and to supply peak heavy ion currents of 15 mA at duty factors up to 50%, for the SuperHilac. The generator is a modified Dynamitron-type shunt-fed Cockcroft-Walton using silicon diodes operated at 100 kHz. The insulating gas is 80% N_2, 20% CO_2 at 250 psi. The 8 foot long high voltage column is horizontal and supports a 2000 lb. terminal. The ion source utilizes plasma-heated cathodes in a PIG discharge. The desired charge state is selected with the aid of a 129° bending magnet. Communication with the terminal is by means of infrared light beams using PCM telemetry. (auth)

50290 NOMINAL ONE-MEGAVOLT, PULSED POWER GENERATOR. Martin, T. H. (Sandia Labs., Albuquerque, N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 104-5(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A pulsed voltage generator, called Frizz, has been designed and constructed at Sandia Laboratories and is now being used as a voltage source for breakdown studies of various materials. Frizz generates a nominal 100 ns pulse of variable risetime from 5 to 50 ns across a vacuum chamber in which dielectric test samples are placed. (auth)

50291 INTEGRATED ION SOURCE GAS CONTROL AND ^3He RECOVERY SYSTEM. June, M. N.; Lovelady, J. L.; McFarlin, W. A. (Texas A and M Univ., College Station). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 106-7 (Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The design and operational characteristics of an ion source gas control system are discussed. The system enables the selection of four different gases, measurement and control of the gas flow, changing of the gas selected with automatic vacuum purging of the manifold, and the blending of two gases by selection switches on a remote panel. The basic system was expanded to incorporate an integrated helium-3 gas recovery and purification system utilizing a fused-quartz ETI SLM-1A helium diffusion cell. The advantages of this "non-LN_2" approach to helium-3 recovery are discussed. (auth)

50292 PERFORMANCE OF THE ANL DYNAMITRON TANDEM. Cox, S. A. (Argonne National Lab., Ill.); Hanley, P. R. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 108-12(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The Dynamitron Tandem Accelerator is now fully operational at ANL. Measurements of beam performance are reported. The dc proton beam current obtained at 8.0 MeV was 53 μA. Peak pulsed proton and deuteron currents measured with a fast Faraday cup were 1100 μA at 1.3 nsec FWHM and 700 μA at 2.0 nsec FWHM, respectively. Beam energy stability (ΔE at E) was less than 140 eV at 1.88 MeV and 820 eV at 6.00 MeV as indicated by the thin target yield of $^7Li(p,n)^7Be$ and $^{27}Al(p,n)^{27}Si$. Operational experience during the first year is discussed. (auth)

50293 TERMINAL ION SOURCE SYSTEM FOR THE BROOKHAVEN THREE-STAGE TANDEM FACILITY. Benjamin, J. A. (Brookhaven National Lab., Upton, N. Y.); Diener, J. J.; Glasoe, G. N.; (and others). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 118-22(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A negative ion source has been installed and operated reliably in the high-voltage terminal of the injector accelerator at the Brookhaven Three-stage MP Tandem Van de Graaff facility. Negative ions extracted directly from an off-axis type duoplasmatron are focused, mass analyzed, and pre-accelerated to match the beam optics of the acceleration tubes. The ions are then deflected through 90° onto the acceleration axis using an improved electrostatic mirror and steered for optimum beam transmission. Other design features include multiple control rods, TV telemetry, surge-protected power supplies, terminal vacuum pumping, closed-loop liquid cooling and high-speed insulating-gas transfer which permits quick access to the terminal. Beams in excess of 30 μA, $^1H^-$ and 5 μA, $^{16}O^-$ have been accelerated by the injector to over 9 MeV. Less intense beams have been further accelerated through all three stages to provide 30 MeV, $^1H^+$ and 100 MeV, $^{16}O^{8+}$ for experimental use. (auth)

50294 RECENT ADVANCES AND DEVELOPMENTS IN ELECTROSTATIC ACCELERATORS. Chmara, Frank; Charpentier, Robert (High Voltage Engineering Corp., Burlington, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 123-5(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Negative heavy ions (O^-, Cu^-, AlO^-, Au^-) produced in a negative ion source were injected into and accelerated through a one megavolt tandem accelerator. Transmission of the various charge states was measured over a terminal voltage range of 300 to 1000 kilovolts. For all the heavy ions, the most abundant charge state at 1 megavolt terminal voltage was 2^+ using oxygen stripper gas. Up to 0.57 particle microamperes of 2^+ were measured for all ion species. Also, using various electrode shapes and materials, studies were made on the role of the pre-breakdown currents and microdischarges on individual as well as on multiple sections of specially designed high gradient acceleration tubes. Optimum engineering techniques were investigated for the insulator profile, the vacuum triple joint, the electrode shape, the material integrity and the generator components associated with the acceleration tube. (auth)

50295 OPERATION OF THE LAMPF 750-keV INJECTOR. Allison, Paul W.; Emigh, C. Robert; Meyer, E. A.; Mueller, Donald W.; Stevens, Ralph R. Jr. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 126-9(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The LAMPF injector system for the high-intensity proton beam has been in operation since June 1970. The beam requirements of a 750-keV, 25-mA beam of protons at 6% duty factor have been met. The system employs a duoplasmatron ion source, a Pierce geometry accelerating column, a Cockcroft–Walton high-voltage generator, and a 40-ft long beam-transport line. The ion source runs at 25-A arc current with 350 microns (gauge) of H_2 in the arc chamber and yields a beam with 70% protons. The emittance of the 25-mA proton beam is $<2\pi$ cm-mrad with no observable growth along the beam-transport system. A variety of beam diagnostic equipment has been installed in this system and results of beam measurements are presented. (auth)

50296 METHODS OF ENERGY CONTROL DURING DISCHARGE OF LARGE ELECTROSTATIC ACCELERATORS. Purser, K. H.; Liebert, R. B.; Petersen, A. N. (Univ. of Rochester, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 130-1(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

In the MP Tandem an energy of approximately 25,000 Joules is stored within the electrostatic fields of the accelerator when it is operated at 10 MV. When the electrostatic fields collapse rapidly during discharge conditions, large transient currents and high voltages are produced throughout the accelerator. In future tandem accelerators with design aims of 20 MV or higher, the stored energy may well be above 100,000 Joules and attention

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must be paid during the design phase to arrangements which will transform the stored energy into heat. Some of the ways in which non-inductive dissipative elements might be incorporated into an electrostatic accelerator to convert the electrostatic field energy into heat and to prevent the excitation of transient oscillations are described, and the results of some preliminary tests which have been conducted at Rochester are presented. (auth)

50297 HEAVY ION DEVELOPMENT AT TAMVEC. McFarlin, W. A.; Wilson, W. B.; June, M. N.; Chapman, W. W. (Texas A and M Univ., College Station). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 132-4(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Heavy ions were first produced and accelerated by the TAMVEC using a floating cathode (Ehlers), P.I.G. type source. Although limited by a 3 KW power supply and cooling design, this source was used in the successful extraction of small quantities of $^{12}C^{+4}$ of energies up to 170 MeV and $^{14}N^{+3}$ of energies up to 90 MeV. Operational characteristics are presented on versions of this source, with added anode cooling, powered cathodes, and beam gating. In recognition of the need for greater arc power and advanced source design, a 40 KW arc power supply and hot cathode P.I.G. type source, similar to the Morozov design, have been fabricated and installed. Observations and operational characteristics with this increased capability are reported. In addition, techniques of extracting a low intensity beam of highly charged particles in the presence of high background spill beams are discussed. (auth)

50298 REMARKS AT THE PANEL DISCUSSION ON SUPERCONDUCTING LINAC DEVELOPMENT. Hahn, H. (Brookhaven National Lab., Upton, N. Y. Kernforschungszentrum, Karlsruhe, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 135(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The gap between theoretical predictions and experimental results in the field of rf superconductivity is pointed out, and possible areas for rf superconductivity research are outlined. (W.H.K.)

50299 SOME REMARKS ON SUPERCONDUCTING NIOBIUM LINACS. Halama, H. J. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 136(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The fabrication and results of preliminary measurements on superconducting iris-loaded structures for electron linacs and rf separators are discussed. The two manufacturing methods discussed include hydroforming niobium plates followed by machining and machining parts directly from solid niobium billets. (W.H.K.)

50300 CONTRIBUTION TO THE PANEL DISCUSSION ON SUPERCONDUCTING LINAC DEVELOPMENT. Kuntze, M. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 137-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The status of superconducting linac development at Karlsruhe is briefly outlined, and various technical problems encountered are discussed. (W.H.K.)

50301 RECENT INVESTIGATIONS OF THE ORSAY GROUP ON RF PROPERTIES AND APPLICATIONS OF SUPERCONDUCTING CAVITIES. Septier, A.; Nguyen Tuong Viet (CNRS, Orsay, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 139-40(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

After intensive experimental studies on high stability oscillators, theoretical work on different physical processes to induce localized transitions to the normal state at high field levels in superconducting cavities is in progress. A theoretical study of beam dynamics in low energy electron linacs (in the 1 to 5 MeV range) shows that a standing wave structure has interesting focusing properties for short bunches injected in the "unstable" phase domain and that a single TM_{010} cavity could be used to obtain electrons of 2 MeV. (auth)

50302 REMARKS FOR THE PANEL DISCUSSION ON SUPERCONDUCTING LINAC DEVELOPMENT. Wilson, P. B. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 141(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Comments are presented on two problems in superconducting linac development. The reproducibility and stability of the superconducting properties of practical accelerating structures and the frequency dependence of the rf magnetic breakdown field are briefly discussed. (W.H.K.)

50303 STATUS OF THE SUPERCONDUCTING 2 GeV LINEAR ELECTRON ACCELERATOR. Suelzle, L. R. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 146-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The design and construction of the accelerator is discussed. In particular, the design of the niobium accelerating structure, refrigerator, dewar, helium distribution system, and the injector and control system are described. (auth)

50304 PERFORMANCE OF THE ILLINOIS SUPERCONDUCTING LINAC. Hanson, A. O. (Univ. of Illinois, Urbana). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 149-52(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The first section of the 1.3 GHz superconducting linac, being constructed for the proposed 600 MeV microtron, was installed into the cryostat and operated as an accelerator for the first time. An electron beam of 270 keV, chopped to a select phase spread of 6 degrees, was injected into the $3\lambda/2$ niobium structure and accelerated to 1 MeV with an input of 30 watts of microwave power at 4.2°K. The accelerated beam was 2 mm in diameter 3 meters beyond the accelerating section. The energy spread was less than 1%. The niobium section had not been outgassed at high temperature and had a Q of 1.4×10^8. The energy gain seemed to be limited to about 1 MeV per foot by field emission, as indicated by the rapid rise of the x-ray yield as the microwave power was increased. (auth)

50305 EFFECTS OF ELECTRONS ON SUPERCONDUCTING CAVITIES IN THE GHz REGION. Dammertz, G.; Hahn, H.; Halbritter, J.; (and others) (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 153-7(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

In superconducting cavities in the GHz region several field-dependent effects have been observed. Besides well-understood effects due to H^2 or E^2 such as radiation pressure one encounters also strange effects which are explained by pre-breakdown field emission rather than by multipactoring as previously suggested. The presence of field-emitted electrons limits the power fed into the cavity and may cause a strong inductive loading of the cavity, permitting a pulling of the oscillating frequency by more than 10 kHz above the small-field resonant frequency. Since this effect could seriously hamper a frequency-tuning servo-system, a detailed study on niobium cavities was carried out, the results of which are presented. (auth)

50306 INVESTIGATION OF THE SURFACE RESISTANCE OF A NIOBIUM-CAVITY AT S-BAND. Kneisel, P.; Stoltz, O.; Halbritter, J. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 158-9(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Measurements of the rf-residual surface resistance of superconducting niobium have been carried out between 2 and 4 GHz. The experiments show that also for type II superconductors like niobium, the losses due to frozen-in magnetic flux can be described by $R_{res} \propto \omega$ (anomalous skin effect). For negligible frozen-in flux, the residual losses are proportional to $\omega^{1.8 \pm 0.2}$ as in the case of lead, indicating that a general mechanism seems to be responsible for these residual losses. (auth)

50307 SUPERCONDUCTING RESONATORS IN THE PRESENCE OF RADIATION PRESSURE AND FREQUENCY FEEDBACK. Schulze, D.; Strube, H.; Mittag, K.; Pioszcyk, B.; Vetter, J. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 160-1(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

In the presence of high radiation pressure, appropriate frequency feedback allows stable operation of a resonator at any

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operating point on the resonance curve. In addition, the electromagnetic forces can be used to damp mechanical oscillations caused by external forces. (auth)

50308 TERMINATION EFFECTS IN HELICAL WAVEGUIDES. Sierk, A. J. (California Inst. of Tech., Pasadena). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 162-3 (Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A superconducting linac composed of a series of $\lambda/2$ standing wave cavities formed by shorting the ends of the helical coils to the outer walls of the cavities is proposed, and field calculations for this configuration are briefly discussed. (W.H.K.)

50309 RF LOSSES IN SUPERCONDUCTING LEAD CAVITIES. Tombrello, T. A.; Leich, D. A. (California Inst. of Tech., Pasadena). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 164-5(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The simplicity of fabrication of lead cavities for a superconducting linac as compared to similar structures made of niobium makes it desirable to understand the source of the high residual RF losses that are observed in superconducting lead. It has been proposed that these losses can be explained by the presence of dielectric layers (probably PbO) on the surface of the superconductor. For a reasonable loss angle ($\sim 10^{-3}$) this requires a layer 0.1 μ thick. The ^{16}O concentration on samples from actual cavities was measured using a resonance in the $^{16}O(^3He,\alpha)^{15}O$ reaction near 2.4 MeV. If the oxygen is assumed to be in the form of PbO, the thickness observed is $0.01 \pm .002$ μ. This result is remarkably constant among the various samples and shows no correlation with the Q of the original cavity or the age of the samples. (The samples had not been exposed to normal atmospheric humidity.) Other possible RF loss mechanisms are discussed. (auth)

50310 MEASUREMENTS ON SUPERCONDUCTING Nb PROTOTYPE STRUCTURES AT 1300 MHz. Turneaure, J. P. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 166-7(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Twenty-four low temperature measurements have been made on six different superconducting Nb cavities at 1300 MHz. These cavities were fabricated using Nb sheet and electron-beam welding and were processed using ultra-high-vacuum firing. Unloaded Q's as high as 4×10^9 and peak surface electric fields as high as 16 MV/m have been achieved. (auth)

50311 SUPERCONDUCTING NIOBIUM CAVITY MEASUREMENTS AT SLAC. Allen, M. A.; Farkas, Z. D.; Hogg, H. A.; Wilson, P. B.; Hoyt, E. W. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 168-71 (Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The program of measurements at SLAC on superconducting niobium cavities is described. Results for TE and TM mode X-band cavities are presented. An RF magnetic breakdown field of 960 gauss and Q values greater than 10^{11} were measured for an electron beam welded TE_{011} mode cavity at 10.5 GHz. The best result for a TM mode cavity was a Q of 1.4×10^9 and a breakdown field of 360 gauss, limited probably by the quality of the electron beam weld. Data on the effect of exposure to air and to nitrogen are presented. (auth)

50312 APPLICATION OF TRAVELLING WAVE RESONATORS TO SUPERCONDUCTING LINEAR ACCELERATORS. Fowkes, W. R.; Wilson, P. B. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 173-5(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The energy gradient in a superconducting accelerator is limited by the peak electric and magnetic fields present at the surface of the accelerating structure. This limitation suggests the use of a traveling-wave structure in preference to a standing-wave structure in order to achieve the maximum possible accelerating gradient. To take advantage of the traveling-wave mode of operation, a low-loss superconducting structure must be incorporated into a traveling-wave resonator (TWR) configuration. However, in a typical superconducting TWR ($Q_L \sim 10^8$) extremely small mismatches ($\Gamma \sim 10^{-6}$) can degrade the forward accelerating wave and increase the peak-to-effective field ratio by coupling power into the reverse wave. The TWR theory is extended to include the case of a superconducting accelerator with beam loading. The effect of mismatches and of perturbations in the phase length of the traveling wave loop on the phases and amplitudes of the forward and reverse waves is calculated. Numerical examples are given for the TWR structure (project Leapfrog) now under construction at SLAC. (auth)

50313 MICROWAVE SYSTEM AND MODULAR COMPONENTS FOR THE ILLINOIS SUPERCONDUCTING LINAC. Hoffswell, Robert A. (Univ. of Illinois, Urbana). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 176-80(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A general description of the microwave system using feedback stabilization methods to control the phase and amplitude of various rf fields in the accelerator is presented. Particular emphasis is given to the use of microstrip transmission-line techniques in the design of microwave system components. The use of such techniques permits the integration of microwave and electronic circuits to provide compact modular subsystems which may be used as components of the microwave system. All subsystem designs may be easily fabricated at relatively low cost. (auth)

50314 DESIGN STUDY OF A SUPERCONDUCTING DEFLECTING CAVITY. Bauer, W. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.); Dammertz, G.; Eschelbacher, H. C.; (and others). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 181-5(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The superconducting rf beam separator now being constructed at Karlsruhe requires two 3m-long niobium deflectors, which are capable of operating with an equivalent deflecting field of at least 2 MV/m corresponding to an rf peak field of 250 G. At present, three different uniform periodic $\pi/2$-mode structures are investigated to determine a suitable fabrication technique, but it is anticipated to build the final deflector with a biperiodic $\pi/2$-mode structure. The problem of mechanical tolerances is analyzed by means of equivalent circuits, and the preferable arrangement of tuning plungers is indicated. Questions which arise from the needs for (1) frequency tuning of the cavity, (2) prevention of mode rotation, and (3) cold rf windows in the input coupler are discussed. Results from measurements of quality factor and peak field in deflecting cavities are presented. (auth)

50315 RADIO FREQUENCY SUPERCONDUCTING STUDIES AT ARGONNE NATIONAL LABORATORY. Moretti, A.; Dawson, J. W.; Peerson, J. J.; Lill, R. M.; Rebuehr, M. T. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 186-7(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A number of tests on superconducting lead-plated cavities and superconducting lead-plated, iris-loaded deflecting structures were carried out. The best result for the cavity was a Q_0 of 7.4×10^9 for the TE_{011} resonant mode at 2.856 GHz. For the iris-loaded structure a Q_0 of 2.2×10^8 was achieved at 1.8°K for the deflecting $2\pi/3$ mode and an equivalent deflecting field of 500 kV/m. (auth)

50316 SUPERCONDUCTING NIOBIUM S-BAND CAVITIES. Halama, H. J. (Brookhaven Ntional Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 188-92(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Recent studies of long-pulse separated beams indicate the need for the development of superconducting rf separators for counter experiments. To achieve this goal microwave resonators at S-band frequencies manufactured by the three following methods 1) machining from solid electron-beam-melted niobium, 2) electroforming in molten fused salts by the Linde Company, and 3) machining hydroformed cups of commercial grade niobium were investigated. Machined parts were electron-beam welded to form microwave cavities. All cavities were heat treated in either the Oak Ridge, Stanford or SLAC high-vacuum, high-temperature furnaces and chemically polished. Both surface resistance and peak rf magnetic field of the above cavities were studied and compared after every step. An improvement factor of $\sim 10^6$ at $\tilde{B} = 330$ G was measured in a TE_{011} cavity. The highest rf magnetic field achieved was 464 G in the TM_{010} mode which corresponds to $\tilde{E}$ of ~ MV/m. In addition, peaks in the microwave absorption caused by rf magnetic field induced surface states similar to those reported by various researchers on highly polished crystals in low dc magnetic fields were sought. No such anomalies were found. (auth)

50317 COLLIDING BEAMS: PRESENT STATUS; AND THE SLAC PROJECT. Richter, B. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 193-5(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The present status of colliding beam devices is reviewed, and the limitations on their performance are discussed. Recent modifications to the design of the Stanford electron position storage ring are also discussed. (auth)

50318 PERFORMANCE OF THE CEA COLLIDING BEAM FACILITY. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 196-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The CEA Colliding Beam Facility is a 6-GeV electron synchrotron which has been modified to operate as an electron-positron storage ring. The facility has an operating range of 1 to 3.5 GeV in each beam and a design luminosity of 10^{31} cm^{-2} sec^{-1}. The design parameters, status, and operating characteristics are discussed. (W.H.K.)

50319 EXPERIENCES DURING THE EARLY RUNNING-IN PHASE OF THE ISR. Johnsen, Kjell (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 199-203(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The CERN Intersecting Storage Rings (ISR) produced the first proton–proton collisions at 15 GeV on January 27, 1971. These tests and other earlier ones with a beam in only one ring are described. Further data and observations during the continuing running-in period are included. (auth)

50320 CONCEPT AND GENERAL DESIGN OF AN ELECTRON PULSE STRETCHER. Servranckx, R.; Laclare, J. L. (Univ. of Saskatchewan, Saskatoon). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 204-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The ring electron pulse stretcher (E.P.S.) for the 100-300 MeV electron linear accelerator of the University of Saskatchewan is described. The results of a previous study made by the particle optics division (S.O.C.) of Saclay for the ALIS are briefly outlined, and its relation to the present design are shown. The present E.P.S. machine design and characteristics are discussed and finally some remarks are made on tolerances and vacuum requirements. (auth)

50321 INJECTION IN A RING WITH NON LINEAR ELEMENTS AND ENERGY SELECTIVE RESONANT EXTRACTION FROM A RING. Laclare, J. L; Servranckx, R. (Univ. of Saskatchewan, Saskatoon). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 207-9(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Coupled vertical-horizontal injection in an electron ring is described. A method for computing injection parameters while the extraction and correction hexapoles are on is given. Achromatic extraction is described as well as an energy selective extraction. In the latter, electrons are extracted with an instantaneous energy spread of 0.8 percent and with an energy scan of 1 to 2 percent during the 1.6 m sec extraction process. (auth)

50322 DESIGN OF A 960 MeV ELECTRON STORAGE RING TO PROVIDE SYNCHROTRON RADIATION FOR XUV AND SOFT X-RAY SPECTROSCOPY. Rowe, E. M.; Pruett, C. H.; Steben, J. D.; Winter, W. R. Jr. (Univ. of Wisconsin, Stoughton). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 210-12(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The investigation of the electronic and optical properties of solids, liquids and gases in the extreme ultraviolet and soft x-ray regions has been carried out with considerable success utilizing synchrotron radiation from the 240 MeV PSL electron storage ring. At the present time, fourteen groups are actively involved in experimental programs at this storage ring. Experience gained over the past three years of operation and the increasing demand for radiation at shorter wavelengths have led to the design of a second generation storage ring designed specifically to supply synchrotron radiation over the range 2 Å to 2000 Å. Injection will be from the present 240 MeV storage ring or from a 30 to 40 MeV microtron. To handle increased gas loads during beam on time, internal pumps in the bending magnets will be used. The acceleration system will operate on the fourth harmonic. The magnet lattice will employ the same unit cell structure as the 240 MeV PSL storage ring but with a super periodicity of 8 and a bending radius of 2.56 meters. (auth)

50323 WAVELENGTH SHIFTER FOR THE UNIVERSITY OF WISCONSIN ELECTRON STORAGE RING. Trzeciak, Walter S. (Univ. of Wisconsin, Stoughton). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 213-16(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

In order to enhance the synchrotron radiation experimental program at PSL, a series of three magnets is being designed to be inserted in a long straight section of the 240 MeV electron storage ring. Two of these magnets (each with a 12.5 kG peak field for a 4° bend) will be inverted so as to deflect the equilibrium orbit 1 cm radially away from the ring center. The central magnet will have a maximum field of about 25 kG and will turn the beam through 8°. The synchrotron radiation power spectrum from this central high field magnet will peak at 50 Å. Using the Courant and Snyder formalism, tune shifts of $\Delta\nu_x = 0.028$ and $\Delta\nu_z = 0.024$ have been calculated for an optimum design—all magnets are to be wedge shaped for normal beam entry and exit at full excitation and each of the magnets will have a constant field gradient of $n = \frac{1}{3}$. Stopband widths at nearby resonances have been calculated to be ≤ 0.057 and are considered to be quite tolerable. Calculations have also been carried out to insure that the "wavelength shifter" does not adversely affect the synchrotron radiation damping rates. For the optimum design, the maximum change to the damping rates will be less than 10%. (auth)

50324 STATUS REPORT ON THE ELECTRON–POSITRON STORAGE RING ADONE. Tazzari, S. (CNEN, Frascati, Italy). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 217-20(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Data on the first year of operation and on recent bunch length and luminosity measurements at the electron-positron 1.5 GeV/beam storage ring Adone are presented. (auth)

50325 POSITRON–ELECTRON MULTICYCLE INJECTION AT THE CEA COLLIDING BEAM PROJECT. Averill, R. J.; Hofmann, A.; Little, R.; (and others) (Harvard Univ., Cambrige, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 221-3(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A reliable procedure for multicycle filling of the CEA ring with positrons and electrons was developed. The positron fill-rate is determined by the intensity, spectrum, and emittance provided by the 125-MeV positron linac and also by the available phase-space and momentum-acceptance aperture of the synchrotron for off-axis injection. This aperture in turn depends on the width of the already stored beam. Losses of newly injected particles in subsequent acceleration cycles depend on the extent of radiation damping provided by special damping magnets. After measuring and optimizing the main parameters, a positron accumulation rate of 0.4 mA/sec was achieved. The control system used in rapid changeover from 125-MeV positron injection to 250-MeV electron injection is sufficiently stable, automatic, and fast-acting that filling the synchrotron ring with counter-traveling positron and electron beams takes less than five minutes. (auth)

50326 ELECTROSTATIC SEPARATION OF STORED BEAMS AT CEA. Dickinson, T. (Cambridge Electron Accelerator, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 224-5(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

CEA—Counter-rotating electron and positron beams in the Cambridge Electron Accelerator are separated vertically by a system of 29 pairs of electrostatic plates distributed around the ring and bypass. When the energy of the beams is above 1 GeV, the plates are powered at a constant level of positive and negative 25 kV. During beam injection the voltage is modulated at a 60 cycle rate from 5 kV to 25 kV to maintain optimum separation as the energy cycles from 240 MeV to 2 GeV. The separation system is arranged to cause the beams to cross in the interaction region. However, since this crossing causes an unacceptable level of beam–beam interaction during injection and subsequent transition to constant energy storage, a system of high voltage switches changes the plates from a no-crossing to

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a crossing configuration after electron and positron beams are stored at constant energy. The switchover is done with full voltage on the system. The design of the plates, power supply and distribution system is described, and experience with the system is recounted. (auth)

50327 BEAM BUMP WITH PROGRAMMABLE WIDTH AND AMPLITUDE. Colby, Wm. F.; Hofmann, A. (Harvard Univ., Cambridge, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 226-7(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A circuit producing a pulse of over 100 A and a width programmable from 2 to 16 μsec has been developed to power a beam bump. The switching circuit involved two SCR's. The pulse width is controlled by changing the timing of the SCR triggers. An inductance in series with the circuit and additional diodes has been used to avoid any overshoot or undershoot during switching. The beam bump is part of the damping system used for accumulation and storage of electrons and positrons in the Cambridge Electron Accelerator ring. During multicycle filling the beam bump backleg windings move the beams approximately 1.5 in. transversely into the damping magnets while the beam energy is near maximum. In order to store the particles at constant energy, the ac component of the synchrotron magnets excitation is decreased and the dc component increased. At the same time the beam bump pulse is continuously increased in width and finally switched into a steady state condition. The conversion process is completed with no loss in beam current. (auth)

50328 AGS CENTRAL RF POWER AMPLIFIER. Rheaume, R. H.; Cottingham, J. G.; Sanders, R. T.; Tranis, A. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 228-32(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The AGS central Rf power amplifier has logged over 6000 hours of accelerator service at normal beam energies, intensities, and duty cycle. The twelve orbital cavities are driven by remote ferrite-coupled final amplifier stages through long matched pairs of coaxial cables from a central RF building. The final stage inputs are paralleled in groups of six for energizing by a pair of identical drivers which, in turn, are parallel-excited from a smaller predriver. There are no tuned stages. Wide-band coupling is achieved throughout the amplifier with ferrite networks. A common dc anode rectifier in the same building powers the driver and final stages. Cavity tuning and AGC loop commands are generated at the output terminals of the final stages. The design, construction, and performance of the new amplifier are discussed. (auth)

50329 RF ACCELERATING SYSTEM FOR THE CERN PS BOOSTER. Bigliani, U.; Nassibian, G.; Reich, K. H.; Zanaschi, D. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 233-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The basic parameters of the RF accelerating system for the 800 MeV CERN PS Booster (PSB) were determined for raising the CPS intensity by an order of magnitude without increasing significantly the longitudinal bunch area. In each of the four PSB rings the acceleration will be provided by a single RF cavity consisting of two ferrite loaded quarter wave coaxial lines. The four cavities are superposed in the same straight section in order to save space for future developments, and are thus severely limited in height (<360 mm). To help ensure high reliability, and ease of cavity replacement, forced air cooling was chosen. Ferrite biasing is achieved by means of two figure eight loops. The final stage of the RF amplifier is located at the cavity while the driver and preamplifier stages are centralized. Special problems encountered are reported and the adopted solutions described. (auth)

50330 STUDY AND DESIGN OF NAL MAIN RING ACCELERATOR CAVITY. Arfin, Bernard; Friedlander, Fred (Varian Associates, Palo Alto, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 237-40(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

This cavity, intended for the 200 GeV proton synchrotron, is resonant at 53 MHz and tunable over a 0.55% frequency range. There are two gaps across which at least 240 KV has to be developed when driven by a tetrode having an rf voltage of 20 KV. An equivalent circuit model was used as an aid in solving this problem. A no-load gap voltage of 270 KV has been measured. A principal requirement was to minimize interaction between the harmonic components of the beam and the cavity. A scale model showed over 130 higher order cavity modes up to the 20th harmonic. Undesirable modes were damped by selective coupling to coaxial and waveguide loads with negligible damping of the fundamental mode. A relativistic proton beam-gap-interaction computer program based on ballistic theory was used to calculate the beam-loading conductances and gap-coupling coefficients for the most significant modes over the design energy range. The effective gap voltages of the modes were then calculated by the program to provide quantitative criteria for evaluating the damping. (auth)

50331 NAL MAIN-RING CAVITY TEST RESULTS. Griffin, J. E.; Kerns, O. A. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 241-3(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Two prototype main-ring accelerating cavities of slightly different design are under test. A description of the existing resonators is given. Test results and new developments are reviewed, and methods for damping unwanted resonator modes are discussed. (auth)

50332 RF FERRITE-TESTING PROGRAM AT NAL. Kerns, Q. A.; Sandberg, B. R. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 244-5(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Investigations at NAL on ferrite disclosed a time-dependent rf loss phenomenon occurring only at high power. To provide cores of adequate power-handling capability for both the booster and the main-accelerator cavities, 2,962, 8-in. o.d. ferrite toroids from two manufacturers were tested. Of these, 1,078 were tested at both low and high power and the rest at high power only. The central portion of the test apparatus was a half-wave coaxial cavity impedance-matched to a 5 kW power amplifier. The low-power test was performed at three levels of dc bias, up to 28,000 ampere-turns per meter. A programmed frequency synthesizer and automatic reduction and plotting of data are features of the low-power test. The high-power test delivered over a kilowatt of power to a single toroid and was done at a single dc bias. The core selection criteria for booster toroids differ from those for main-accelerator toroids; the selection process is described. (auth)

50333 100 kW RF POWER AMPLIFIER. Kerns, Q. A.; Miller, H. W. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 246-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A 100 kW power amplifier with a power gain of 47 db over 30 to 53 MHz and a signal delay of less than 50 nanoseconds has been designed to power the rf cavities in the booster accelerator and the main accelerator of the NAL proton synchrotron. Phase and delay characteristics are important features of the design because the amplifier is operated within a cavity phase-stabilization feedback loop. The amplifier, of modular construction, is packaged in a 16-in. diameter by 30-½-in. cylinder mounted on the rf cavity. The output stage is a grounded-grid 100 kW power tetrode driven by 14 parallel 800-watt tetrodes. A powdered-iron choke functions in a 3 kW matching network between the lower and upper halves of the cascade stage. The input to the cascade is provided by a six-tube distributed amplifier. Techniques for achieving satisfactory shielding and reverse-signal attenuation are described. (auth)

50334 BAR LOADED WAVEGUIDE FOR ACCELERATOR SERVICE. Tigner, Maury (Cornell Univ., Ithaca, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 249-50(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The design and performance of a bar loaded or jungle gym type waveguide for accelerator service is described. The waveguide is operated in a traveling wave resonant ring. This structure is particularly easy to cool for very high power use, is easy to fabricate and has large error tolerances because of its unusually broad fundamental pass band. (auth)

50335 ACCELERATOR CAVITY AND THE ASSOCIATED RADIO FREQUENCY SYSTEM FOR THE ZERO GRADIENT SYNCHROTRON INJECTOR BOOSTER. Dawson, John W. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 251-2(Jun 1971).

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From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The development of the accelerating cavity for the ZGS injector booster is described. The philosophy of the over-all rf system and electronics implementing this system are described. (auth)

50336 RF SYSTEM FOR SLAC STORAGE RING. Allen, M. A.; McConnell, R. A. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 253-4(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The rf system for the electron-positron storage ring which presently is under construction at SLAC is described. The rf frequency is 51 MHz which is the 40th harmonic of the rotation frequency. The radiated energy will be restored by one or more rf cavities. Presently 180 kW of rf power is available. This power is sufficient to store over one ampere at 2 GeV with a single cavity and about $\frac{1}{5}$ ampere at 3 GeV with three cavities. (auth)

50337 200 kW AMPLIFIER UTILIZING FOUR U. H. F. TV KLYSTRONS. Nicholls, Gilbert (Cambridge Electron Accelerator, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 255-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The Cambridge Electron Accelerator has need for reliable amplitude controlled cw uhf power for accelerating and storing positron and electron beams in the synchrotron. 200 kW (continuous operation) are needed which is more than can be provided by the existing system. For reliability a new system was developed utilizing 4 individual amplifiers equipped with Varian 953C klystrons. The 55 kW outputs are combined in coaxial 3 dB hybrids. The combined outputs are then combined to the 200 kW level in a waveguide 3 dB hybrid. For reliability there is no switching in the combiner; the combiner has sufficient isolation to allow servicing a klystron while the remainder of the system is operating. The theoretical and observed efficiency is compared and the drive system used to linearize and equalize the four klystrons is described. (auth)

50338 HIGH PERFORMANCE KLYSTRONS FOR ACCELERATOR APPLICATIONS. Tallerico, Paul J. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 257-9(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A six cavity, $1\frac{1}{4}$ MW, 805 MHz klystron for the Los Alamos Meson Physics Facility (LAMPF) has been designed at Los Alamos and fabricated at Litton Industries. The design requirements were all exceeded by the experimental tube and a maximum dc to rf conversion efficiency of 57.4% was measured. The design and performance of the klystron are discussed. (auth)

50339 MODE DAMPING IN NAL MAIN RING ACCELERATING CAVITIES. Dehn, R. A. (General Electric Microwave Tube Operation, Schenectady, N. Y.); Kerns, Q. A.; Griffin, J. E. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 260-1(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Beam stability in the NAL main ring synchroton may be adversely affected by high impedances presented to the beam by the accelerating cavity gaps at harmonics of the fundamental rotational frequency Ω (about 47.7 KHz). It is proposed to maintain the cavity gap impedance at an acceptably low level over the frequency range from 47.7 KHz to 1 GHz. Above the 53 MHz operating frequency resonant mode density becomes very high. In this frequency range frequency-dependent resistive damping is employed to reduce the cavity gap impedance. The damping material is a nickel-zinc ferrite which exhibits low magnetic and dielectric loss at 53 MHz but the magnetic loss rises steeply with frequency above 100 MHz. Energy from unwanted resonances is coupled to the lossy ferrite through apertures in the cavity endwalls. Coupling improves with increasing frequency. The effectiveness of this type of damping is discussed and plots of the cavity gap impedance versus frequency are presented. (auth)

50340 STATUS OF THE NEVIS SYNCHROCYCLOTRON MODIFICATION. Rainwater, J. (Columbia Univ., New York). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 262-7(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The conversion retains the basic cyclotron magnet (2000 tons of Fe and ~300 tons of Cu coils), but adds a 10-in. thick Fe band around the outside magnet perimeter to lower the return path reluctance. A new larger vacuum chamber is used, with auxiliary excitation coils. Pole iron within 30 in. of the median plane is replaced by a new configuration which includes N = 3 symmetry sector iron with a small median plane gap. $\langle B \rangle$ = 18 kG near the center and 20 kG near 80 in. radius. Strong azimuthal magnetic field flutter begins at <2 in. radius to give strong focusing ν_z, and $\nu_r \neq 1$. It is expected to obtain ~550 MeV proton energy, with high extraction efficiency for a 10 to 40 μA time average external beam (~50% duty factor), when operation starts later this year. The system will still be a synchrocyclotron and will have a 300 Hz FM repetition rate, with a new RF system, etc. (auth)

50341 STATUS OF THE UNIVERSITY OF MARYLAND CYCLOTRON. Johnson, W. P. (Univ. of Maryland, College Park). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 268-71(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The University of Maryland Cyclotron has been available for use by experimentalists since summer, 1970. A brief description of the main features of the cyclotron and of the facilities currently available for experiments is presented. Operation of the cyclotron is discussed and the results of a few tests on the external beam are presented. Finally, data obtained from three experiments are presented to demonstrate the over-all energy resolution available for a given experimental setup. (auth)

50342 TRIUMF, MARCH 1971. Warren, John B. (Univ. of British Columbia, Vancouver). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 272-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A general description of the Tri-University Meson Facility (TRIUMF) is given, and the status of the project is outlined. (W.H.K.)

50343 TWO-STAGE, TWO-GAP, LIGHT- AND HEAVY-ION CYCLOTRON STUDY. Wright, B. T.; Igo, G. J.; MacKenzie, K. R.; Richardson, J. R.; Verba, J. W. (Univ. of California, Los Angeles). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 277-81(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A detailed study of a separated-magnet two-stage cyclotron has been completed. For elements heavier than S, ions are preaccelerated by a 700 keV Cockroft–Walton and then injected into the first stage (lower gap) of the cyclotron. After acceleration, extraction and stripping (from charge Q to 4Q) they are returned to the center of the second stage (upper gap, whose center line is 15 inches above that of the lower gap) and further accelerated. For ions lighter than S, preacceleration takes place in a small cyclotron and the ions are injected directly into the second stage of the large cyclotron. Protons may be accelerated from 4 to 200 MeV, ^{3}He from 12 to 630 MeV and U from 620 to 2130 MeV. Heavy ion currents are limited by heating and sputtering of the electrostatic deflector extraction system. The turn separation for uranium ions at the final radius is 16 mm, so extraction efficiencies above 90% should be possible. At 90% it is estimated that 1 particle microampere of uranium ions will be obtained. Features and details of the design are presented. (auth)

50344 CENTRAL REGION ORBIT DYNAMICS IN THE TRIUMF CYCLOTRON. Louis, R. J.; Dutto, G.; Craddock, M. K. (Univ. of British Columbia, Vancouver). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 282-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Orbit dynamics in the central region have been studied with the aim of optimizing the design for beam quality and RF phase acceptance. Axial ion motion near the center is dominated by the strong phase dependent RF electric forces at the dee gaps; the consequent restriction of the phase acceptance to ions lagging the RF voltage peak can be lifted both by using an asymmetric dee gap geometry and by the addition of third harmonic to the RF fundamental. A transition from six- to three-sector magnet geometry at the center to increase the axial focusing was also tried, but was found to give rise to unacceptable ±9° phase oscillations if the dee gap were oriented to avoid the usual gap crossing resonance. Other effects producing coherent radial oscillations, such as first harmonic magnetic field components and dee-voltage asymmetries, have been assigned tight tolerances. The proposed design also makes possible near perfect centering for ions of all phases. Numerical orbit tracking has shown that a beam with the emittance of the external ion source can be accelerated to 20 MeV within 0.25 π in. mrad for an RF phase band at least 25° wide; in

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the absence of inflationary effects at higher energies this would yield a 500 MeV beam with ±600 keV energy resolution. (auth)

50345 SOME ORBIT CALCULATIONS FOR TRIUMF. Bolduc, J. L.; Mackenzie, G. H. (Univ. of British Columbia, Vancouver). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 287-91(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A numerical technique for obtaining solutions of ill-conditioned linear equations is described that has proved useful when trying to produce a desired field with 54 trim coil pairs using the method of least squares, and in calculating an isochronous field. A phase dependent centering error which can distort the horizontal emittance of beams with positive phases, thus limiting the phase acceptance of a cyclotron is described, and tolerances for field imperfections imposed by certain resonances in TRIUMF are reported. These calculations are chiefly concerned with phenomena away from the immediate central region and consequently electric focusing forces have been ignored. (auth)

50346 ANALYSIS OF CYCLOTRON-TYPE ELECTRIC LENSES AND THE EFFECTS OF POSTS. Han, C. S.; Reiser, M. (Univ. of Maryland, College Park). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 292-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The focusing properties of cyclotron-type electric lenses with time-varying potentials were investigated by analytical and numerical methods. First-order focusing formulas are derived which include the effects of a "liner" and of focusing grids. The main emphasis of the numerical studies was on the aspects of lens effects which had not been previously investigated: (a) The behavior of the lenses at large transit times or rf frequencies for which the approximations of analytical theory are not valid. (b) The effects of posts (or grids) placed at one or both sides of the gap. The lens parameters, i.e. focal lengths and location of principal planes, are computed numerically for several geometries using electric field data obtained by computer with relaxation method. Computations are carried out for several two-dimensional and three-dimensional gap geometries at three different frequencies of the gap voltage as a function of kinetic energy and rf phase of the particles at the center of the gap. A criterion for the validity of first-order theory is established. The application to cyclotrons is discussed briefly. (auth)

50347 FEASIBILITY STUDY TO INCREASE THE AVAILABLE TAMVEC PROTON AND DEUTERON ENERGIES. Poulsen, Niel B. (Texas A and M Univ., College Station). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 297-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

These studies show: (1) that with reasonable modifications to the panels in the RF cavity and the addition of a driven RF oscillator TAMVEC's maximum proton energy can be increased from 50 MeV to 70 MeV, (2) that re-wiring the trim and valley coils external to the cyclotron would facilitate increasing the maximum deuteron energy from 60 MeV to 70 MeV and, (3) that combining the above two modifications would further increase the proton energy to 80 MeV. (auth)

50348 BEAM DIAGNOSTICS AND IMPROVEMENTS AT TAMVEC. Wilson, W. B.; McFarlin, W. A.; Rogers, R. C.; (and. others) (Texas A and M Univ., College Station). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 299-302 (Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Internal beam measurements performed with a variety of beam current probes and photographic techniques are discussed. This work revealed a large spread in the time and energy spectra of extracted beams due to the phase width of the internal beam and poor dee voltage regulation. Devices installed to restrict the radial spread of the internal beam, including a remotely positioned radial extension of the ion source and radially driven beam obstacles, and their effects on the time spectrum of the beam are discussed. Modifications improving dee voltage regulation and the development of a frequency-independent dee voltmeter are described. (auth)

50349 NEVIS SYNCHROCYCLOTRON CONVERSION PROGRAM-RF SYSTEM. Schneider, R.; Yen, P.; Rainwater, J. (Columbia Univ., New York). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 303-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The ⟨B⟩ for the revised Nevis Synchrocyclotron magnet will increase from 18 kG at the center to 20 kG at 80 inches radius. This gives 27.48 MHz at injection, and 19.23 MHz for extraction (550 MeV, 76 inch radius). The resonator will be tuned so that $f_{min} = f_{extraction}$ including a slow RF turnoff where $df/dt \approx 0$ for adiabatic energy damping. The peak dee voltage ≥30 kV with the maximum near injection. The repetition rate will be 300 Hz with <50% RF duty factor. The single dee and dee stem structure will be ~150 inches wide and 163 inches long. One of the three pairs of sector-iron shims is to be incorporated into the dee and the assembly supported on cooled alumina structural insulators. The resonator frequency is varied by two rotating capacitors located at the end of the dee stem, which is split outside the magnet circle. Excitation of the resonator will be provided by a grounded-grid, triode oscillator having the anode and cathode coupled to the resonator via coupling loops and transmission lines of proper length and impedance. A series tube modulator will permit the slow linear RF turnoff needed for adiabatic energy damping of the phase oscillations before extraction. (auth)

50350 SOME ESSENTIAL FEATURES OF THE ROTARY CAPACITOR IN CONSTRUCTION FOR THE IMPROVED 600 MeV SC OF CERN. Beger, H. H. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 307-10(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The improvement of the CERN 600 MeV SC foresees the installation of a hooded arc ion source together with an RF-system capable of furnishing 30 kV with a nominal repetition rate of 466 Hz. The modulation between 30 MHz and 16.7 MHz will be done by means of a rotary capacitor, which differs in some technological points from rotary capacitors used elsewhere until now including specially shaped blades to obtain a duty-cycle of ~64%; hydrocarbon free vacuum by utilization of a turbomolecular pump in order to permit high electrical field strength between the capacitor electrodes; application of turbopump blades within the capacitor as a rotating oil vapour barrier; bridge circuit in order to reduce RF currents across the ball bearings; and utilization of special type ball bearings to increase lifetime. The basic concept of the RF-system including the capacitor was worked out by CERN, whereas detail design as well as manufacturing were done by industry. (auth)

50351 ORBIT DYNAMICS OF THE INDIANA UNIVERSITY CYCLOTRON. Bardin, Bryce M.; Hettmer, James H.; Jones, William P.; Kost, Cornelis J. (Indiana Univ., Bloomington). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 311-14(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A comprehensive package of computer programs has been developed to facilitate the study of the orbit dynamics of the Indiana University Separated Sector Cyclotron. Coupling between the radial and axial motion is intrinsic to the ray tracing programs. Ion accelerations are performed using sector-to-sector non-linear phase space transformations. Model magnetic fields are generated by combining measured edge-falloff data with the radial gradient necessary for isochronism. Calculations have also been carried out on measured fields using bicubic spline interpolation. Effects of various resonances have been studied and are discussed. (auth)

50352 DESIGN OF THE NEW RF-SYSTEM FOR THE 600 MeV SYNCHROCYCLOTRON AT CERN. Kannowade, H. H. (AEG-Telefunken, Frankfurt am Main). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 315-18(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

AEG-Telefunken is developing and constructing a complete new rf-system for the 600 MeV Synchro Cyclotron, as part of the CERN improvement program. The main parts of the system are the dee, a connecting line, a rotating capacitor and a rf-generator, coupled capacitively to the system. A 1:5 scale model has been built to measure the characteristics of the dee. In addition to this, the dee is computed as a plane network of capacities and inductivities. Both results are compared. 1:5 scale models of the rf-generator and the rotating capacitor have been built and measured by CERN. To match the various components, computations have been performed with the help of a common computer program (UNIV). It readily provides resonance frequencies and impedances as well as voltages and currents at all points of the circuit. The circuit is inserted as data. The program is completely described. A 1:1 scale model of the complete rf-system has been built. The results

of the measurements are compared with the results of the computations. (auth)

50353 MULTI TURN AND SINGLE TURN EXTRACTION FROM THE BONN ISOCHRONOUS CYCLOTRON. Euler, K.; Schild, F.; Thimmel, H. M.; Wucherer, P. (AEG-Telefunken, Frankfurt am Main). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 319-20(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The isochronous cyclotron of the Bonn University is a multi-particle variable energy machine. The relative low maximum energy of 30 MeV deuterons results in a total turn number of 150 and a large turn separation of 4 to 5 mm at the extraction radius. The precessional extraction before $\nu_r = 1$ is used. The adequate coherent radial amplitude of approx. 4 mm is generated in the central region of the machine. By using this mechanism we extracted beam currents in the 50 μA region with high extraction efficiency of about 80 p.c. The emittances of the extracted beam are 10 mm mrad in two directions. In the multi turn mode of operation the phase space measurements showed the energy dispersion effect. By using a two slit system the machine has been operated in the single turn mode. (auth)

50354 BEAM MATCHING PROBLEMS CONCERNING THE AXIAL INJECTION SYSTEM FOR THE KARLSRUHE CYCLOTRON. Luetter, W. P.; Schild, F.; Thimmel, H. M.; Wucherer, P. (AEG-Telefunken, Frankfurt am Main). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 321-5(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

To operate the cyclotron with polarized ions an axial injection system has been ordered at AEG, associated with the construction of a new RF-system. During a shut-down period of three months the complete new system will be taken into operation this summer. The system has to operate with an external source as well as with an internal source. The central region and the axial beam line have been calculated to have a full transmittance for a phase space area of 500 mm mrad in both directions and a phase width of 30° (related to the RF) in the 3ω-mode. (auth)

50355 CURRENT EXTRACTIONS CHANNEL OF THE NEVIS SYNCHROCYCLOTRON CONVERSION PROJECT. Cohen, R.; Martin, E.; Ziegler, K. (Columbia Univ., New York). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 326-7(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A current channel has been designed (computer) with a septum of 0.120 in., having a field jump of over 5 kG and having a field distortion outside the channel of less than 70 G. This small distortion can easily be reduced with small iron shims. The field inside the channel has a gradient of about 1 kG/in. which corrects the drop of fringing field so that the field index of the combined fields is $n \approx 0.5$. The heat load and the power dissipation in the septum will be greatly reduced by having the septum flair out from 0.100 in. at the upstream end of the channel to about 0.600 at the downstream end. (auth)

50356 BEAM STACKING AND LONG BURST OPERATION IN SYNCHROCYCLOTRONS. Lindbaeck, S. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 328-31(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

It is shown that particles filling an rf bucket in a synchrocyclotron can be stacked with a minimized energy spread if the accelerating voltage and frequency are suitably matched. Samples of energy distributions of the stacked beam calculated by computer for various voltage and frequency programmes are presented. Various systems for producing long burst operation by secondary acceleration or orbit displacement are examined and the calculated characteristics of the beams obtained are compared. (auth)

50357 GENERAL DESIGN FEATURES OF THE FOUR-METER ISOCHRONOUS CYCLOTRON AT DUBNA WITH A SMOOTHLY VARIABLE HEAVY ION ENERGY. Shelaev, I. A.; Vorob'ev, E. D.; Zager, B. A.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 332-4(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The four-meter isochronous cyclotron of JINR is being constructed for acceleration of intense beams of heavy ions with the ratio of mass A to the charge Z equal to 3.5 to 25 proton units and a smoothly variable energy in the range of 400 to 625 Z^2/A MeV. The main physical parameters and ideas of this accelerator are given. (auth)

50358 APPLICATION OF AN ON-LINE COMPUTER TO ACCELERATOR STUDIES. Barton, Mark Q. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 335-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The use of an on-line computer to expedite accelerator studies may be one of its most important applications. A discussion of some of the types of problems for which computer assistance is of value is presented, and some implications on the configuration are described. (auth)

50359 INTRODUCTORY REMARKS FOR THE PANEL DISCUSSION ON COMPUTER CONTROL. Evans, Don M. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 337(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The control environment of the Bevatron is divided into a system of well-defined tasks, each capable of being treated individually but not separately. To maintain the individual aspect, but integrate all of the component tasks into a system structure, the "multi-processor" concept of system organization is utilized. It was recognized that bulk-storage elements could not be provided separately for each processor, and in fact, advantage could be gained by utilizing the moderate speed disc-storage as a common-memory element thereby allowing the main-frame memory of each mini-computer to act as "cache" memory for each arm of the quasi-multi-processor. This allows the use of overlay techniques to provide an apparent vastly expanded software capability. (auth)

50360 STRUCTURE AND USE OF A COMPUTER CONTROL SYSTEM. Lewis, Lloyd G. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 338-9(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See Conf-710308.

A general description of a computer control system is given, and the Zero Gradient Synchrotron computer is discussed. (W.H.K.)

50361 ON THE CERN PS COMPUTER CONTROL SYSTEM. Madsen, J. H. B. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 340-1(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A brief description of the IBM 1800 computer hardware and software for control of the CERN Proton Synchrotron is given. (W.H.K.)

50362 WIRERUN: A COMPUTER PROGRAM FOR WIRING LARGE PROJECTS. Case, J. R. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 345-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

WIRERUN is a computer program developed to produce and maintain wiring and termination records for the Los Alamos Meson Physics Facility (LAMPF). The program has nearly eliminated the need for the thousands of drawings that would have been required to make the original installation of wires and cables. From simple input data, a variety of output listings can be obtained, each of which is designed to fulfill a specific need, such as cable-pulling information, wire-termination instructions, trouble-shooting listings, and others. All information normally found on wiring drawings is presented in a computer listing form that is easy to read and aids greatly in the reduction of wiring errors. The use of this program by designers to assist them, from the inception of a design to its completion, and how it aids them in the prevention of common design errors are discussed. (auth)

50363 BEAM DIAGNOSTICS AT THE CERN PS BOOSTER. Koziol, H.; Reich, K. H. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 347-51(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A description of all beam diagnostics equipment for the CERN PS Booster is given. The following items are discussed in more

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detail: a computerized system of position pickup electrodes, a 900 MHz electromagnetic pickup station, the fast measurement of the betatron-tune, and the measurement line for the ejected beams (spectrometry and emittance measurements). (auth)

50364 BEAM CONTROL SYSTEM FOR THE CERN PS BOOSTER. Bigliani, U. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 352-3(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Because of the tight tolerances on longitudinal dilution each ring of the PSB has a completely independent beam control system of the "closed-loop" type, including a phase-lock and a radial control. Before the transfer to the CPS the bunches of the four rings are synchronized in phase. The phase information detected by means of five electrodes is filtered by an automatically tuned filter of high performance (±4° over the entire amplitude and frequency ranges). The output from a phase discriminator linear over the 2π range controls a fast voltage controlled oscillator (response to a step is ~20 ns). The radial control comprises a beam-derived frequency program and a damping system for beam-shape oscillations. In order to achieve synchronization without dilution, special considerations had to be given to the adiabaticity and lock-in range of this process. Digital techniques and modular construction are widely used. A detailed description of the system is given together with the results of performance test on the CPS, including synchronization to a reference frequency. (auth)

50365 COMPUTER ASSISTED CONTROL AND DATA ACQUISITION SYSTEM FOR THE CERN PS BOOSTER. Asseo, E.; Baribaud, G.; van der Beken, H.; (and others) (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 354-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

For the 800 MeV CERN PS Booster (PSB) strong emphasis is laid on control and data acquisition and treatment by computer to accelerate a dense beam of 10^{13} p/p after a relatively short running-in period. This accelerator really consists of four superposed and partly independent synchrotrons and a large number of data has to be digested in a short time. A substantial saving is obtained by relying entirely on the computer, leaving out direct manual control. Instead of acquiring a new machine, it was decided to link the PSB to the already well-established IBM 1800 of the CPS. Its capacity will be considerably enlarged to cope with the increased load and to offer software facilities providing a great flexibility for each of the three machines served (Linac, PSB, CPS). A satellite computer has been added to act as a function generator in order not to load the IBM 1800 too heavily with real-time work. A technical description of the whole system is given, followed by a survey of the application programs. (auth)

50366 AUTOMATIC CONTROL OF THE JUELICH BEAM HANDLING SYSTEM. Reich, J.; Gebauer, W.; Schlienkamp, G. (Institut fuer Kernphysik, Juelich, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 359-60(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

In a first step to automate the beam handling control at the Juelich Isochronous Cyclotron, electronic equipment has been designed and tested. The system allows to automatically activate all beam handling components according to a preselected beam path. In a second step of automation a link to a PDP-15 computer will be provided. (auth)

50367 BEAMLINE COMPUTER CONTROL BY INTERPRETER. Adams, Peter (Rutherford High Energy Lab., Chilton, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 361-2(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The computer control system for the K9 separated beam at NIMROD is described. This beamline is a multi-energy/multi-particle beam and the principal aim of the computer system is to reduce the time taken to tune the beam to a new energy. The hardware comprises a 12K PDP-8 with disc and magnetic tape, a teletype and logging typewriter. Control of the magnet currents and collimators is via a multi-crate CAMAC system, which also serves for data acquisition. The software system is based on a real-time, high level language interpreter. Besides allowing the users to write their programs in a high level language (similar to FORTRAN), the interpreter also provides all the executive functions required with a disc-based, real-time system. Because an interpreter is used, programs can be written or modified on-line and tried out immediately. This feature can be used also to test out hardware. A simple test program can be written and run in a matter of minutes. The relatively slow execution speed of the interpreter is no disadvantage. The system allows high level language and machine code program segments to be combined in any program. (auth)

50368 STANDARD INTERFACE CONCEPT FOR COMPUTER-CONTROLLED PARTICLE ACCELERATORS. Machen, D. R.; Biswell, L. R. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 363-4(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A survey of the existing (and planned) particle accelerators throughout North America and Europe will immediately indicate the unmistakable proliferation of either partial or total digital computer control systems. The cybernetic-like tentacles of these systems have reached into the remotest areas of the particle accelerator. One also realizes that each facility has designed special hardware, unlike any other, to handle the interface problem between the accelerator and the computer. A further look will convince one that the various interface problems are similar. The practical solution to the standard interface concept for computer control systems is discussed. Such an accelerator/computer-independent scheme for interface could well save many man-years of redundant design effort and invoke considerable cost savings in system implementation. A system organized about the dataway and branch/control highway of the CAMAC standard is a potential contender. (auth)

50369 SOLID STATE CONTACTOR FOR USE IN 60 Hz, 3 PHASE SERVICE. Cilyo, F. F.; Kerns, Q. A. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 365-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A solid-state step-start contactor using back-to-back thyristors has been developed at NAL for switching on and off the ac power input to the ferrite-bias supplies of the booster and main accelerators. The water-cooled thyristors are designed to switch 3 phase 500 A rms at 480 V, 60 Hz; the minimum ac line current can be zero without affecting the switching operation. The thyristors are turned on by a rectified 50 kHz carrier signal. This signal is transmitted to the thyristor gate circuit via a high-isolation transformer. A 3-phase current sensor and a solid-state interlock and status-monitor display unit form an integral part of the contactor. The contactor is designed to open if the line current exceeds the preset limit or if any of the interlocked variables such as over-temperature or blown-fuse condition occur. The logic AND of the interlock unit prevents the turning on of the contactor until the abnormal condition is corrected. (auth)

50370 BEAM INHIBIT SYSTEM FOR LAMPF. Criscuolo, A. L. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 367-8 (Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A review of the design and operation of the Los Alamos Meson Physics Facility (LAMPF) Fast Protect System (FPS) is presented. The FPS is an electronic system that provides very rapid shutdown of the accelerator beam in the event of a beam spill or a malfunction of any of the critical systems of the accelerator. This system operates to shut down the beam in approximately 7.5 μsec, of which 4.5 μsec is the one-half mile long transmission-line propagation delay. The FPS is comprised of three subsystems: Control Logic, Transmission System, and Shutdown Logic. The Control Logic monitors critical systems in each of 14 areas of the facility and signals the Shutdown Logic, via the Transmission System, when a malfunction is detected. The Transmission System, which runs the length of the accelerator, functions as a distributed "AND Gate" for beam turn-on. The Shutdown Logic at the Injector quickly inhibits beam whenever it loses the signal from the Transmission System. A review of fail-safe features, computer testing, and hardware implementation is included. (auth)

50371 ACCURATE DETERMINATION OF THE RF WAVEFORM AT TRIUMF. Gummer, R. H. M. (Univ. of British Columbia, Vancouver). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 371-2(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The simple rectangular shape of the resonant accelerating dees used in the TRIUMF cyclotron permits the addition of the third harmonic to the rf voltage. The resulting flat-topped waveform gives rise to many improvements in the acceleration process.

Instrumentation which measures the flatness of the rf voltage waveform peak is described. (auth)

50372 COMPUTER ASSISTANCE IN EXPERIMENTAL AREA OPERATIONS AT THE ZGS. Hoffman, Earl W. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 373-4(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

An XDS Sigma 2 computer is being used for monitoring and control of various items in the ZGS experimental area. Computer assistance is available to both regular operating personnel and experimenters via satellite CRT consoles. The current status of several systems is immediately available at the consoles, and changes in the systems under control can be affected. Experiences in the areas of monitor and control of magnet power supplies and mass separators, tuning of beam line magnets, monitoring of beam line performance, and monitoring of radiation levels are presented. (auth)

50373 PRECISION COAXIAL MANGANIN SHUNTS. Praeg, Walter F. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 375-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Precision and relatively inexpensive four-terminal resistors (shunts) of coaxial design have been developed at Argonne National Laboratory for measuring and controlling constant or pulsed magnet currents. Air and water cooled shunts for currents between 50 A and 10 kA have been built. Their frequency response ranges from dc to tens of kilohertz, and their resistance is reproducible within ±0.001%. These shunts have Manganin resistance elements. The resistance-stress coefficient of shunt-Manganin for pressure transverse to the direction of current flow was determined. This permits calculation of change in resistance due to pressure of the shunt coolant. The shunts can serve as secondary standards to calibrate other current measuring devices. (auth)

50374 ON-LINE COMPUTATION AND PRESENTATION OF EXTERNAL PROTON BEAM LINE TARGETING INFORMATION. Knott, M. (Argonne National Lab., Ill.); Hornstra, F. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 377-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The system described calculates both horizontal and vertical beam size and center position at each experimenter's target. The measuring devices are of the nondestructive multiple-wire type. The necessary multiplexing and synchronized sampling of the devices are controlled by the Zero Gradient Synchrotron (ZGS) control computer. As soon as the data are available, a program is called upon to calculate the beam center position and full width at half maximum. As these values are calculated, they are formatted and multiplexed to displays for the ZGS operators and to the experimenters' location. The system processes up to eight profile devices and supplies results on a pulse-to-pulse basis immediately after the beam spill time. (auth)

50375 TORSIONAL STRAIN AND VIBRATION MONITOR FOR THE MOTOR-GENERATOR SHAFT OF THE ZERO GRADIENT SYNCHROTRON (ZGS). Lewis, Lloyd G.; Brescia, Albert A. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 379-81(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A monitoring system has been developed for measuring the torsional strains and torsional vibrations produced in the motor-generator shaft by the pulsed operation of the ring magnet of the Zero Gradient Synchrotron. The detection of these vibrations makes it possible to readjust the ring magnet cycle to prolong the life of the shaft. The monitoring system uses stainless steel bands mounted on the shaft. These bands contain engraved markings that are sensed by the optical system that controls the digital electronics. The system makes over 800 digital measurements of strain during each revolution of the generator shaft. Alarms and shutdown circuits are activated if the strain exceeds a safe limit. A digital-to-analog converter produces an output for displaying strain and vibrations on a conventional oscilloscope. (auth)

50376 INSTRUMENT FOR MEASURING BETATRON RESONANT FREQUENCIES. Potts, C. W. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 382-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

An instrument has been developed to measure betatron tunes in the ZGS with a minimum of disturbance to normal operation. In one mode of operation, the beam is driven by a frequency sweeping voltage controlled oscillator (VCO). The output of this VCO is compared to $(1-\nu)$ feedback from the beam in a phase-sensitive demodulator. The dc output of this demodulator helps to control the frequency of the VCO, thus closing a loop around the beam. At frequency coincidence between the $(1-\nu)$ feedback and the VCO, a pulse is generated which stops the VCO frequency sweep and allows phase lock on the beam if desired. This pulse also activates measuring and digitizing circuitry to record pertinent data at the instant of frequency coincidence. Other modes of operation permit measurement of, and phase lock to, unexcited or "natural" resonances. (auth)

50377 LASL MULTI-COMPUTER VAN DE GRAAFF CONTROL AND GRAPHIC DISPLAY SYSTEM AND EXPERIMENTS WITH AUTOMATIC BEAM OPTIMIZATION. McMillan, Dean E.; Collins, M. W.; Woods, Richard (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 389-93(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The LASL Van de Graaff Facility includes two accelerators, an 8 MeV vertical and a 16 MeV tandem. Subsystems are being monitored and controlled by a Honeywell H610 process control computer. To improve the man/computer/accelerator communication an Adage AGT/10 graphics system was obtained. This random scan, computer based system can support 4 terminals. A communication link that can connect the Adage system to 8 computers was built by LASL so that, in addition to the display capability, the AGT/10 serves as a central computer switchboard. Presently the AGT/10 is connected to the H610 and a XDS 930 computer used for data acquisition. Control and monitoring functions have been implemented using the graphics system. It has proved particularly valuable in the optimization problem where many variables are being changed simultaneously. Multiparameter optimization algorithms suitable for nonlinear objective functions with constraints are being tested on the tandem. Ones which have large tolerance to variations in the measured quantities and fast convergence are being sought. Results to date are given. (auth)

50378 SLAC CONTROL ROOM CONSOLIDATION: SOFTWARE ASPECTS. Howry, S.; Johnson, R.; Piccioni, J.; Waithman, V. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 403-4(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

SLAC is consolidating its two control rooms by utilizing existing control computers in each, connected by a communications link. Except for video signals, all of the controls and data of one (Central Control Room) will be sent to the operators in the other (beam switchyard control room) using this system. The software aspects of this project are discussed, and the major program components are described. (auth)

50379 PROPERTIES OF A PARALLEL DIGITAL DATA TRANSMISSION ROAD FOR CONTROL APPLICATION. Besse, L. J. (Swiss Inst. for Nuclear Research, Zurich). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 405-6 (Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The present trend towards digital information processing in particle accelerators dictates the need of a special purpose, highly-noise-immune data transmission system with cable lengths up to several hundreds of meters. The ROAD-facility (Rapid Operation and Acquisition Dataway) was designed as essential hardware for remote data transmission (control + monitor) between control room and all accelerator equipment. Not only the distances between various equipment locations and the control room but the nature of periodical adjustments (slow/frequent) prohibit the use of large quantities of cables for unique individual control. By using the control computer system with its ability to store or send information sequentially (by scanning one at a time), it was decided to use a time-address-division-multiplex-system. The parallel signal transmission is very attractive since encoding/decoding equipment is commonly available with inexpensive MSI-TTL technique. In consequence, to ensure a reliable operation even in very noisy environments (common mode noise, earth problems, etc), the transmission circuitry has been designed to have a minimum of ±3 V noise immunity (common mode). (auth)

50380 PRESENT STATUS OF THE SOFTWARE FOR COMPUTER CONTROL IN THE CERN ISR PROJECT. Kemp, D.; Keyser, R.; Tausch, L. (CERN, Geneva). IEEE (Inst. Elec.

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Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 407-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A multi-programming system has been written to schedule the various application programs and to exploit the hardware attached to the CERN ISR control computer system. Certain features of the system, in particular those that concern its operation, are described as well as a synopsis of the applications. (auth)

50381 SLAC CONTROL ROOM CONSOLIDATION USING LINKED COMPUTERS. Breymayer, K.; Constant, T.; Crook, K.; (and others) (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 409-11(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Consolidation of two large accelerator control rooms using digital computers connected by a data link is described. Several consolidation plans are discussed and the adopted solution is described. The key elements are touch panels operating with a TV display system. (auth)

50382 COMPUTER INTERFACE DESIGN BETWEEN A MASTER COMPUTER AND A SLAVE COMPUTER FOR SIMULATION CONTROL AND INSTRUMENTATION MONITORING OF THE BROOKHAVEN 200 LINAC ACCELERATOR. Frankel, R.; Pyros, I. E. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 412-13(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

An interface design is proposed for tie-in between a master computer and a slave computer for transferring of data and control signals between the 200 MeV linear accelerator and a master computer station. Device control, device selection and control for a party line I/O bus, sensing techniques, and graphic display simulation are discussed. Also, programs that could be utilized for optimization of machine parameters are discussed. (auth)

50383 INNOVATION IN CONTROL PANELS FOR LARGE COMPUTER CONTROL SYSTEMS. Fryberger, D.; Johnson, R. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 414-17(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A control panel of novel design has been developed at SLAC. This panel, called a Touch Panel, consists of a glass plate placed in front of a computer driven cathode ray tube display. Ultrasonic surface (Rayleigh) wave (8.5 MHz) beams are transmitted in a crossing X-Y grid through the glass. The intersection points of the beams form the "buttons" on the panel. The presence of an operator's finger on the glass "pushing" a button is detected by the absorption of an X and a Y beam. A prototype panel has been used successfully with an SDS-925 computer for magnet control in the SLAC beam switchyard. A second generation panel with low parallax and compact electronics has been built and tested. An extensive software system, utilizing numerous "software panels," for general control of the accelerator, the beam switchyard, and their associated sub-systems has been developed. The physical principles of the device, its advantages and disadvantages over conventional devices, current hardware and software implementation, and future plans are discussed. (auth)

50384 KNIFE SWITCH, THE RELAY, AND THE IC. Frankel, R. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 418(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Remote control and data acquisition on a single or at most several wires have been under study at the AGS for some time. Recent advances in integrated circuit technology and significant reductions in the cost of Analog/Digital and Digital/Analog converters have enabled the design of a control system far cheaper (per channel) than similar automatic control schemes and which appears when all costs are included (wire, installation, etc.) to be competitive with conventional manual multiwire systems. The system is based upon the premise that the attached computer does not have to function in order for the control system to operate, but the notion that duplicate controls (computer and manual) be developed has been rejected. The new system might be likened to replacing switches and relays. The relays added additional reliability problems to the system, but their presence permitted control sequences unattainable with practical switch arrays, as well as operation with fewer personnel. The integrated circuit, serial, time multiplex system is the next evolutionary step. (auth)

50385 OPERATOR'S CONSOLE FOR THE LAMPF ACCELERATOR. Butler, H. S.; Hartway, B. L.; Machen, D. R.; Putnam, T. M. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 419-21(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The control system for the LAMPF accelerator is organized around an on-line digital computer. The computer's versatility in acquiring and arranging data for presentation to the operator made a strong impact on the design of the operator's console and the central control room. The racks full of lights, meters, and knobs so typical of a conventional control system were replaced at LAMPF by a compact console in which the prominent device is a graphic display scope with a light pen. The evolution of the present LAMPF operator's console is outlined. The experience gained from a prototype console for a small accelerator is recounted. It was on this console that the concept of graphic control panels was pioneered. The considerations which led to the physical shape of the LAMPF console are explained. A description is given of the various panels on the console which was put into operation in December. An evaluation of the design, based on accumulated experience, is reported. (auth)

50386 MASTER TIMING SYSTEM FOR CEA COLLIDING BEAM PROJECT. Anderson, Bruce C. (Cambridge Electron Accelerator, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 422-3(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The CEA colliding beam project requires trigger signals relative to the e^- and e^+ circumferential beam positions in the accelerator. These triggers are required for proper timing of multicycle injection, steering of the beam into the bypass, triggering of beam monitoring and excitation devices. The synchronizer was built to provide these triggers. (auth)

50387 CENTRAL CONTROL SYSTEM OF THE NAL ACCELERATOR. Klaisner, L. A.; Mellick, P.; Rich, K.; Smith, S. R.; Storm, M. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 424-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A computer-assisted system has been developed to facilitate control of the entire accelerator by one or more operators in the central control room. An operator seated at any one of a number of identical control stations has at hand several small panels containing a knob and push buttons; an operating system in the central computer permits flexible and rapid redefinition of the functions assigned to the panels. Input from a control station represents a sequence of commands that are executed interpretively by the central computer. Individual accelerator components are accessed via a level of mini-computers that are interfaced to the central computer by a serial data-transmission system. Information is most often presented to the operator by a number of video monitors, showing data processed through the computer system, camera-source pictures, or a combination of the two. (auth)

50388 RF CONTROL SYSTEM OF THE NAL ACCELERATOR. Birk, M.; Ducar, R.; Kerns, Q.; Tool, G. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 427-31(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The booster and main accelerator rf systems at NAL have nearly identical control requirements. The equipment for each cavity is controlled and monitored via a module interface unit (MIU). The MIU's connected to a MAC-16 computer via a daisy chain, serve the functions of interfacing the equipment to the computer and providing facilities for manual control and monitoring. Each MIU controls 32 and monitors 128 binary lines, controls 16 analog channels, and monitors 64 analog channels via a multiplexed A/D converter. Each of the three rf control centers contains a MAC-16 computer, an MIU and MADC for control of nonmodular equipment, and a core-memory curve generator providing repetitive driving waveforms. Each MAC-16 may be controlled locally using a teletype, or via serial data links to a central Sigma 2 computer. (auth)

50389 MULTIPLEXED CONTROL SYSTEM FOR THE NAL MAIN ACCELERATOR. Sutter, David F. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 432-4(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

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A Lockheed MAC-16 minicomputer functions as a communications controller to operate a serial-transmission system that sends digital control information at a 1 MHz rate to and from 24 service buildings distributed evenly around the 4-mile circumference of the accelerator ring. Interfacing of monitor and control systems to the serial-transmission system is accomplished at each service building by a house logic unit (HLU). While each HLU can operate up to 8 "device controllers," 4 are normally installed: a 16-channel digital output multiplex, an 8-channel digital input multiplex, a 64-channel multiplexed analog-to-digital converter, and a main magnet power-supply system interface. (auth)

50390 DYNAMICS OF PULSED HIGH CURRENT RELATIVISTIC ELECTRON BEAMS. Graybill, S. E. (Ion Physics Corp., Burlington, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 438-46(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Pulsed electron beams are formed by the slow charge of a pulse forming network (microseconds to D.C.) and the fast discharge (10 to 100 ns) onto a field emission diode. The resultant beams of kiloamps to megamps at hundreds of keV to ten MeV are passed through a window into the drift region. Ionization in the drift section allows the beam to be confined by its own magnetic field. Secondary electron currents in the plasma tend to neutralize this effect. Recent work on guiding intense beams with auxiliary fields has utilized applied B_z and B_θ (z-pinch) fields. Application of these beams extends from shock studies to ion acceleration. (35 references) (auth)

50391 TRANSFORMER TYPE ACCELERATORS FOR INTENSE ELECTRON BEAMS. Abramyan, E. A. (Inst. of Nuclear Physics, Novosibirsk, USSR). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 447-55(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The principles and designs of transformer accelerators (TA) generating intense beams of charged particles over energy ranges 0.5 to 5 MeV are described. Pulse electron accelerators with pulse length of 10^{-8} to 10^{-5} sec are investigated (some of them have a repetition rate of several hundreds pps) as well as one-phase and three-phase 50-cps transformers. The power conversion efficiency is in the range of 60 to 95%, the averaged beam power comes up to or exceeds 10 kW and is in excess of 150 kW for one of the last models. The design of a 5 MeV single-pulse TA with peak current of 30 kA at pulse length of 40 nsec and of a 1.2 MeV proton TA with average beam power of 10 kW is described. The features of main components of high voltage transformers and of intense current acceleration tubes are discussed. (auth)

50392 BERKELEY ERA PROGRAM. Lofgren, Edward J. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 456-9(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The scope and status of the Berkeley Electron Ring Accelerator (ERA) program are reviewed. (auth)

50393 UNIVERSITY OF MARYLAND ELECTRON RING ACCELERATOR CONCEPT. Reiser, M. (Univ. of Maryland, College Park). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 460-5(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The ERA scheme being studied at the University of Maryland with collaboration of NRL and NBS involves the formation of the electron ring in a static rather than pulsed magnetic field. The main technical features, present status of the project, and future plans are reviewed. Preliminary experimental studies with a 2 MeV injector are being carried out at NBS. A 5-MeV injector will be built by NRL. Extensive theoretical investigations have been carried out and design work for the compressor and expansion-acceleration system is in progress. (auth)

50394 PULSITRON: A COMPACT, HIGH-CURRENT ELECTRON BEAM ACCELERATOR. Crewson, W. F.; Naff, J. T.; Jones, C. H. (Pulsar Associates, Inc., La Jolla, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 466-7(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A coaxial high current accelerator design is proposed. A novel feature of this design is that approximately one-half of the required energy is initially stored capacitively in a volume inside the beam. The cylindrical beam is accelerated with a Marx-like circuit. After acceleration, the beam is focused between coaxial biconic conductors to a small cross section. A specific accelerator module design storing 70 kilojoules and capable of producing beam currents greater than a million amperes at 1 million volts is described. The real opportunity of this design is that its compact size will make possible multi-module machines which will have an output far exceeding anything thought practical today. (auth)

50395 STUDIES OF ELECTRON BEAMS FROM A FEBETRON 705. Rhee, M. J. (Univ. of Maryland, College Park); Zorn, G. T.; Placious, R. C.; Sparrow, J. H. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 468-72(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The Febetron 705 is being studied as a possible type of injector for electron-ring accelerators. The standard diode has been replaced with a new structure designed to reduce the emittance of the electron beam. The diode has operated successfully at 2 MeV and, currently, a series of measurements are being made on the beam emittance. Optimization of the diode parameters for the minimum emittance at 10^2–10^3 A is being studied. The emittance of the beam with several choices of these parameters as a function of energy during a pulse is presented. (auth)

50396 FORMATION OF AN ELECTRON RING IN A CUSPED MAGNETIC FIELD. Kalnins, J. G.; Kim, H.; Nelson, D. L. (Univ. of Maryland, College Park). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 473-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

In connection with the University of Maryland electron ring accelerator project, the possibilities of forming the electron ring in a cusped magnetic field were investigated. The results of numerical calculations as well as analytical theory are presented. In order to reduce the ripples in cylindrically rotating beams, and maximum phase space acceptance, a special way of winding coils and use of ferro-magnetic material are proposed. (auth)

50397 HIGH CURRENT PULSED ELECTRON BEAM GENERATOR. Smith, I.; Champney, P.; Hatch, L.; Nielsen, K.; Shope, S. (Physics International Co., San Leandro, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 491-2(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A review is given of a simple and economical method of generating high current electron beams in the range of a few hundred kiloamperes to multi-megamperes at voltages of from 100 kV to 1 MV. Mylar dielectric parallel plate transmission lines switched with either solid dielectric spark gaps or gas spark gaps constitute the pulse forming network. Several such generators have been built that feed a 50 nsec width pulse through a low inductance insulator/vacuum interface to the diode. The electron beam is generated in the diode region and transported through a thin window into a drift chamber. (auth)

50398 NEREUS, A 250 kV, 80 kA ELECTRON BEAM GENERATOR. Prestwich, K. R. (Sandia Labs., Albuquerque, N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 493-5(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A 250 to 400 kV, 80 kA, 30 ns electron beam generator has been developed. The machine consists of a 600 kV Marx generator, a water-dielectric transmission line, a diode, and a beam drift chamber. It was necessary to minimize prepulse for stable diode operation. Several cathodes were tested during development and results are reported. Diodes with 26 and 8 nH inductance are described. (auth)

50399 ION ACCELERATION WITH INTENSE LINEAR ELECTRON BEAMS. Putnam, Sidney (Physics International Co., San Leandro, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 496-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Injection of intense electron beams into drift chambers filled with low pressure neutral gas has been shown to produce protons and heavy ion bunches with energies exceeding the kinetic energy of the beam. Present experimental evidence suggests that the acceleration occurs over about a 10 cm length, corresponding to accelerating fields of the order of 10^6 V/cm. The abrupt cutoff of the acceleration mechanism after utilization of only a fraction of the beam pulse width is considered in the context of the localized

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pinch model, and experiments are suggested to extend the acceleration length. Also, various ion acceleration proposals using linear electron beam geometries are discussed in the light of recent developments in the technology of intense electron beam generation and transport. (auth)

50400 EFFECT OF ACCELERATION AND DRIFT REGION CONFIGURATIONS UPON THE PROPAGATION OF INTENSE ELECTRON BEAMS. McNeill, W. H.; Little, R. G. (Simulation Physics Inc., Bedford, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 499-500(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Previous work has emphasized the application of strong magnetic fields for control of electron beam drift region entrance conditions in order to enhance energy transport efficiency. However, if the diode-generated electron beam is paraxial upon injection, it is known that efficient transport can be achieved in field-free drift regions. Experimental and theoretical investigations have been conducted to assess the effect of diode and drift region boundary condition configurations upon the propagation of both low and moderately high ν/γ electron beams. A conductor placed at the center of a drift region was used to control the return current associated with a space charge neutralized electron beam of $\nu/\gamma = 3$. The effect of the center conductor upon beam energy transport is discussed. Also presented are the results of theoretical investigations which consider the generation of electron beam return currents, energy partitioning between beam particles and fields, and the calculation of electron trajectories in both acceleration and drift regions for an electron beam of $\nu/\gamma = 1$. (auth)

50401 MEASUREMENTS OF ELECTRON RING COMPRESSION IN THE GARCHING ERA. Andelfinger, C.; Herrmann, W.; Schluter, A.; Schumacher, U.; Ulrich, M. (Max-Planck-Institut fur Plasmaphysik, Garching, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 505-7(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Magnetic probe and synchrotron radiation diagnostic measurements for determining the total electron number, the electron density distribution, and the energy in the compressed state at the Garching electron-ring accelerator are described. Results are presented and briefly discussed. (W.H.K.)

50402 STATUS REPORT ON LAMPF. Knapp, E. A. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 508-12(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Progress on the construction of the LAMPF Linear Accelerator is described. Emphasis is placed on the performance measurements made on the 5 MeV beam produced by the first tank of the accelerator; the progress in system adjustment made to achieve stable high power, high duty factor operation; and the progress in achieving computer control of the systems so far operational. The general status of the constructional and operation schedules is also discussed. (auth)

50403 BROOKHAVEN AGS CONVERSION PROJECT. Wheeler, George W. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 513-16 (Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF- 710308.

Most major features of the AGS Conversion Project are at or near completion. The entire project should be completed within a year. The 200-MeV linac injector has accelerated beams to full energy and is undergoing detailed tune-up. The AGS main ring rf amplifier system has been running for a year. The new main magnet power supply has recently come into operation resulting in increased repetition rate and longer flat top for the AGS. Other features are well advanced. (auth)

50404 INITIAL PERFORMANCE OF THE NAL 200-MeV LINEAR ACCELERATOR. Young, D. E.; Curtis, C. D.; Goodwin, R. W.; (and others) (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 517-21(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The design, operation, and initial performance of the 200-MeV linac injector for the NAL Synchrotron are described. (W.H.K.)

50405 LOW VOLTAGE INJECTION INTO THE ELECTRON LINEAR ACCELERATOR. Brown, L. E.; Gallagher, W. J. (Applied Radiation Corp., Walnut Creek, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 522-4(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The use of low gun voltages for linac injection is, in general, impractical because the capture, or trapping, fraction is slight, unless other especially designed injection apparatus is employed. For example, single gap cavities have been used as preaccelerators (rather than velocity modulation prebunchers). Ordinarily, a tapered phase velocity structure suggests itself; however, at very low voltages a reasonable disc thickness excludes any volume for the cavity. A novel constant phase velocity periodic structure to capture and bunch a low voltage beam, currently used in low energy accelerators, is described. A proposed additional use of this scheme is for obtaining very short pulse lengths. Normally, high voltage diode guns have a perveance an order of magnitude lower than low voltage guns, requiring therefore a short high voltage pulse which is difficult to achieve owing to rise (and fall) time. It is suggested that the trapping scheme described, using an achievable, short pulse and low voltage gun will provide short, bunched pulse trains. (auth)

50406 LINAC INJECTION PRE-BUNCHING SYSTEMS. Gallagher, W. J. (Applied Radiation Corp., Walnut Creek, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 525-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The theory of particle bunch formation by means of velocity modulation, produced by single gap cavities, is customarily based on ballistic (or kinematic) analysis. Owing to the ready availability of computers, it is convenient to investigate velocity modulation including space charge forces and using relativistic kinematics. The results of a systematic examination of bunching parameters are presented. The beam loading characteristics of cavities designed to produce the requisite gap voltage are also discussed. (auth)

50407 10 MW LINEAR MODULATOR WITH 500 kHz FREQUENCY RESPONSE. Younger, J. W.; Sides, K. W. (Continental Electronics Manufacturing Co., Dallas). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 529-32(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The NAL Linear Accelerator requires nine (9) RF systems operating at 201.25 MHz. Each of the nine RF systems must deliver 5 MW peak power at a 0.6% duty factor (400 microsecond pulsewidth). The RF source must maintain a correct accelerating gradient in the accelerator cavity under drastically varying load conditions during the pulse interval. Control of the RF energy is accomplished by the use of solid state, optical, and hard tube modulator techniques. The modulator utilizes three high power triodes for linear amplitude control. Modulating pulse voltages range from 100 volts to 35 kV. Precise control is maintained by two-way analog information fed between the exciter and the high voltage deck via a light coupled circuit. The slowing rate of the modulator is 200 kV/μsec and the frequency response is flat from zero to 500 kHz with 60° of phase shift at 500 kHz. Problems of design and test of the modulator are discussed. (auth)

50408 12 MeV S-BAND STANDING-WAVE GUIDE. Whitman, Kenneth (Applied Radiation Corp., Walnut Creek, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 542-4(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The design of a 1.3 m, 12 MeV, S-band, side-coupled, standing-wave structure for electron acceleration is described, and the experimental operating characteristics are given. (auth)

50409 FIELD RADIATED BY AN ELECTRON BUNCH PASSING THROUGH A LINAC SECTION. Papiernik, A.; Wartski, L.; Marcou, J. (CNRS, Orsay, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 545-9(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The field radiated by a single electron bunch crossing a thin slice of linac as well as the entire section of the iris-loaded wave guide has been studied both theoretically and experimentally. Theories are based upon the normal mode expansion of the radiated field in the R.F. structure (traveling wave or standing wave modes). They exhibit the dependence of the dispersion law on the radiated wave forms in which a mixture of the synchronous and cutoff modes mainly appears. Experimental works have been

made by building up a low-energy model in which the negligible electron velocity variation allows the results to be extended to ultra-relativistic accelerators. Radiated fields observed on the TM_{01} mode satisfy the theoretical predicted results, and the method used can be generalized for the study of the upper modes in the iris-loaded wave guide. (auth)

50410 ELECTRON PREBUNCHING WITH SPACE-CHARGE EFFECTS. Tronc, D. (Thomson-CSF, Orsay, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 550-2(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Computation results are presented on electron prebunching, including space-charge effects, which lead to a practical formulation useful for designers. A computer program has been established for an electron beam radially uniform. Results are presented on compression for different parameters including current, electrical field of modulation, and focusing magnetic field. A phenomenological interpretation of the bunching and of the following beam blowup due to space charge is given. The results given by the computation program allow the choice of a simplified model leading to a practical expression for the compression as a function of the main parameters. (auth)

50411 VARIABLE ENERGY ACCELERATING STRUCTURE. Leboutet, H.; Tran Duc Tien (Thomson-CSF, Orsay, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 553-7(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The problem of varying energy in an ion linac is discussed leading to the proposal of a new type of accelerating structure. The proposed structure is derived from the so-called H-type structure and operates with traveling waves. The variation of the output energy, based on the modification of the phase law, is performed by simple adjustment. Verifications have been carried out on experimental models. Field distribution, phase shift law, and adaptation conditions have been studied in the standing wave form as well as in the actual traveling wave operation. (auth)

50412 IMPROVEMENT OF THE BUNCHING IN INJECTORS FOR ELECTRON LINACS. Leboutet, H.; Tronc, D. (Thomson-CSF, Orsay, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 558-60(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Computation results are presented showing an improvement in the final bunching characteristics when a long cavity is used at the beginning of a synchronous classical buncher. An analysis of several combinations has been done and suggests to adjoin at the entrance of such a buncher a long cavity leading to a phase-shift of about $4\,\Pi/3$ for the electron around which the bunching occurs. An improvement by a factor of two is obtained and variations of physical parameters are not critical. Comparison with a synchronous buncher is done, including eventually the use of a modulation cavity with drift space. Results including space-charge effects are given for a practical injector. (auth)

50413 NEW PERFORMANCES OF THE BEAMS OF THE SACLAY'S HIGH DUTY CYCLE LINAC. Aune, B.; Bourbigot, J.; Derost, J.; (and others) (CEN, Saclay, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 561-3 (Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

High resolution electron beam production is described. Energy full width of less than 0.3% is obtained. Half of the intensity is accelerated in an energy bandwidth less than 0.1%. The high power electron beam is used for pion production. Operation at a level above 100 kW (300 μA, 380 MeV) has been tested on the pion source. The best conditions for the high intensity positron beam acceleration are discussed. Various improvements have been made to give more versatility and reliability to the modes of operation. (auth)

50414 MEASUREMENT OF ELECTRON BEAM BUNCH FORM. Land, D. V. (Univ. of Glasgow). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 564-7(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A method for accurately determining the variation of current with phase within the electron beam bunches of a linear accelerator is described. The rf field in a section of the accelerator is dephased by approximately 90° so that the energy of an electron is a function of its phase position relative to this field. The beam is then passed through a magnetic analysis system operating at fixed energy and the analyzed current observed as the phase of the rf field is varied. The factors which can limit the resolution achievable by this technique are detailed and the methods employed to minimize the effects of these are described. The results of measurements made on the Glasgow linear accelerator are presented. (auth)

50415 SPARKING MEASUREMENTS IN A SINGLE GAP CAVITY. Boehne, D.; Karger, W.; Miersch, E.; Roeske, W.; Stadler, B. (Gesellschaft fuer Schwerionenforschung, Darmstadt, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 568-71(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

In two prototype single-gap cavities designed for a variable energy heavy-ion linac, mean gap fields up to 25 MV/m were applied. Spark rate and x-ray level are reported versus gap gradient, electrode material and conditioning procedure. It is seen that copper is rather susceptible to surface contaminations and showed spark rates and x-ray figures increasing by time. Aluminum remained stable. The lowest values have been obtained for titanium, but the rf losses of this material are intolerably high. For short periods a reduction of the x-ray intensity by almost a factor of 20 could be obtained. (auth)

50416 EXPERIMENTAL POSSIBILITIES FOR A 50 MeV ELECTRON LINAC WITH LONG DUTY FACTOR. Baglin, J. E. E. (Iowa State Univ., Ames). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 572-4(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The LAMPF electron prototype accelerator (EPA), offers immediately a proven design for an inexpensive electron accelerator with experimentally excellent beam characteristics: 12% duty factor, 1.5 mA mean electron current, and well-stabilized ($\lesssim$0.5% energy resolution). Operation and control of the EPA are remarkably uncomplicated and reliable. Several classes of important new experiments can be proposed for a 50 MeV version of this machine. The machine is discussed as a practicable and versatile source of polarized monochromatic photons, polarized MeV electrons, and polarized fast neutrons (flight-timed). Also, its use as an intense pulse source of fast neutrons and an intense slow-pulsed thermal neutron source is discussed. (auth)

50417 FIELDS AND FREQUENCY CALCULATIONS IN SIMPLIFIED PERIODIC STRUCTURES. Voisin, G. (Univ., Lyon). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 575-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

An attempt at analysis of simplified periodic RF structures is presented. The method, based upon the expansion of the fields in series of wave guide modes and matching of their components over simple coupling surfaces is described and illustrated in the case of an iris loaded wave guide. (auth)

50418 GENERAL DESCRIPTION AND PERFORMANCE MEASUREMENTS ON DESY LINAC II ELECTRON–POSITRON INJECTOR. Pering, N. C. (Varian Associates, Palo Alto, Calif.); Roome, W. A.; Rush, P. C.; (and others). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 579-83(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Measurements made during acceptance testing of the DESY electron-positron linear accelerator indicate performance approaching the design value. The purpose of the linac is high-current injection to the synchrotron and future electron-positron injection into a storage ring now under construction. The linac consists of twelve 5.2 m constant-gradient sections driven by SLAC-type klystrons operating at 24 MW. A positron current of 1.4 mA within an energy spread of $\Delta E/E \pm \frac{1}{2}\%$ and an emittance of 1 πcm mrad at 385 MeV have been measured. Electron load line and emittance data have been taken. Beam-pulse shortening of the SLAC type occurs above 250 mA. (auth)

50419 HIGH CURRENT ELECTRON LINAC. Gallagher, Wm.; Johnson, K.; Mavrogenes, G.; Ramler, W. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 584-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A new high current (20 A at 10 ns) electron linear accelerator has been installed at the Argonne National Laboratory. It is primarily used for the Laboratory's fundamental research programs in both radiation chemistry and threshold photoneutron studies.

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The accelerator consists of two main accelerating structures. Each is powered by a 20 MW L-band klystron. The electron gun and injector system consisting of two prebunchers and a buncher, have been specifically designed to produce high intensity beams. A 12 A peak current pulse for a time duration of 6 ns is routinely produced in the transient mode of operation. A peak current of 20 A can be achieved with fine tuning. For long pulse operation, 9^{+} μs, the peak current is 2^{+} A. The maximum energy is 22 MeV and maximum joules per pulse is produced at about 13 MeV. A total energy spread of 20% has been achieved for 98% of the output beam when operating in the transient mode. About 83% of the electrons are contained within a 5% energy bin for the long pulse mode. Operating characteristics and design are reported for both the accelerator and the associated beam transport system including the 270° achromatic bending magnets and fine structure (60 ps) beam pulse work. (auth)

50420 SOME MECHANICAL DESIGN AND CONSTRUCTION ASPECTS OF THE MIT-LNS LINAC. Biron, R. D.; Fischer, H. C.; Weaver, J. N. (Massachusetts Inst. of Tech., Cambridge). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 589-91(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A high degree of rf phase stability, throughout a high average power, physically large, microwave system requires careful attention to the design of the mechanical joints, supports and anchors and of the numerous branches of its widely dispersed heat transfer network. The major designs discussed are: the 180-m long coaxial drive line supports, anchors and thermal enclosure (for ±1° phase stability), the rectangular and disk loaded wave guide heat transfer and mechanical support designs, and the two 3000 gpm cooling water systems that are designed to maintain temperatures at 36 ± 0.9°C and 45 ± 0.1°C, respectively. The general design philosophy followed for the mechanical and thermal systems was to build mechanically stable supports and provide a high volume of well temperature regulated water to minimize the effects of operating from a zero to a maximum thermal load. For the most critical thermal circuits (the disk loaded wave guides) metal temperature sensing and feedback controls to water temperature mixing valves are employed. Additional temperature sensing points on the rectangular wave guide could be utilized too, should they prove preferable to electronic phase compensation. (auth)

50421 LOW EMITTANCE HIGH DUTY FACTOR INJECTOR LINAC. Haimson, J. (Massachusetts Inst. of Tech., Cambridge). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 592-4(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The 20 MeV injection system for the 400 MeV high duty factor MIT linac is described, and a report is presented on the initial performance of the 400 kV electron gun and drift space components and the high power buncher wave guide. The high potential, 2856 MHz injection system was designed specifically to produce a low emittance (1 mm-mrad) beam with a narrow longitudinal phase space of 1°, at repetition rates extending to greater than 3000 pps and at duty factors up to 3%. The input RF peak and average power levels can be varied over a wide dynamic range [4 MW, 80 kW, 2% duty, to 1 MW, 65 kW, 6.5% duty], with optimum beam performance occurring in the mid-region of peak RF power and at average currents up to 300 μA. (auth)

50422 HIGHLY PHASE-STABLE RF POWER CIRCUITS FOR THE MIT-LNS LINAC. Haimson, J.; Sargent, C. P.; Weaver, J. N. (Massachusetts Inst. of Tech., Cambridge). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 595-7 (Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The design objective for the MIT medium energy, high-duty-cycle linear accelerator has been to optimize and extend existing technology to obtain a degree of RF phase stability not previously achieved with high power RF systems. The RF system that is described includes: an ultrastable tunable crystal oscillator; a PIN-diode RF modulator; a master driver klystron amplifier; a section of coaxial driveline; a driver klystron; a direct-high-voltage-switching, dual, high-power klystron transmitter; and a rectangular wave guide feed network. Accurate phase bridge measurements on the system, which operates with a maximum average RF power of 80 kW per high power klystron (4 MW peak at 2% duty cycle to 1 MW peak at 6.5% duty cycle) indicate a pulse-top phase stability of better than $1\frac{1}{2}$° at the system frequency of 2856 MHz. Also discussed is a proposed closed loop phase stabilization scheme for control of long term drift and effects of the large dynamic range of the repetition rate. (auth)

50423 FEEDFORWARD CONTROL OF ACCELERATOR RF FIELDS. Jameson, R. A.; Wallace, J. D. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 598-600(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A new and very effective technique for accelerator field control is demonstrated, using a feedforward control loop to complement a standard feedback controller. The accelerated beam current envelope, which acts as a load disturbance on the accelerator field amplitude and phase, is detected upstream from the module to be controlled. Due to differences in propagation velocity in the accelerator and external cables, true anticipating control is possible by feeding the current signal forward to the controller. In tests with full beam loading (22%) in the first 201.25 MHz tank at LAMPF, peak amplitude error was reduced to 0.4% and settling time to 20 μsec at beam turn-on. (auth)

50424 ACCELERATOR FIELD MEASUREMENTS AT HIGH POWER. Liska, D. J.; Jameson, R. A.; Wallace, J. D.; Sharp, J. B. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 601-3(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A technique is described for measuring the field distributions in a chain of coupled rf cavities operating at a pulsed power level of several hundred kW peak. This technique utilizes the concept of bead pull perturbation but requires that special consideration be given to bead design and thread material. Several methods of measuring the field perturbations are discussed which utilize frequency, phase, and VSWR variations. The technique is applied to 136 cell modules of the 805 MHz structure for LAMPF. Each module is driven by a single 1.25 MW klystron and the cell-to-cell field distribution is found to depend in part on the relationship between the drive point and the pickoff point. Comparison is made between high power and low power bead pull data and conclusions are drawn as to the validity of field distribution measurements made at low power. (auth)

50425 RECENT IDEAS ON UPGRADING THE SLAC ACCELERATOR. Miller, R. H.; Helm, R. H.; Herrmannsfeldt, W. B., (and others) (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 604-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

While the present capability of the SLAC accelerator is being fully exploited for physics research, experimenters are becoming increasingly interested in extending the range of beam parameters to higher levels. Several speculative ideas under investigation to upgrade the machine are presented such as: increasing the duty cycle by increasing the repetition rate; increasing the energy either by doubling the number of klystrons or by increasing their power output; increasing the energy by recirculating the beam by means of a magnet transport system and passing the beam through the accelerator twice; causing two 20 GeV beams to collide with each other or one 20 GeV beam to collide with the beam stored in the SLAC storage ring; and perhaps other combinations of these ideas. While the feasibility of these ideas, both technical and economic, remains to be established, it is hoped that one or several of them could be carried out before the ultimate conversion of the present accelerator to a 100 GeV superconducting accelerator that is being contemplated. (auth)

50426 BEAM MEASUREMENTS ON THE FIRST TANK OF LAMPF. Swenson, D. A.; Goplen, B. C.; Paciotti, M. A.; Stovall, J. E. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 609-13(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A variety of measurements have been made on the beam in the first tank of LAMPF. The results of these measurements are compared to the expected results based on beam dynamics calculations. The properties investigated include the transverse admittance of the linac, the transverse emittance of the injected and accelerated beam, emittance growth as a function of beam current, momenta spectra as a function of field level, and the performance of the single and double buncher systems. Some of the techniques used in the measurements are described. (auth)

50427 TUNING AND PRE-BEAM CHECKOUT OF 805 MHz SIDE-COUPLED PROTON LINAC STRUCTURES. Swain, G. R.; Jameson, R. A.; Knapp, E. A. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 614-18(Jun 1971).

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From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The LAMPF 805 MHz linac has 104 side-coupled cavity chains, called tanks, which are joined together in sets of four or two to form 44 driven modules. Each tank has a different cavity geometry. The average fields in the tanks of a given module should agree to 1% in order to preserve satisfactory beam dynamics and to make the turn-on problem tractable. These and other requirements make necessary the custom tuning and checkout of each portion of the accelerator. Methods for tuning accelerating and side cavities before and after they are brazed together into tank sections are described. High power tests of transient behavior, long-term stability, and stopband vs duty factor are outlined and related to structure cooling and frequency errors. Particular attention is given to the problem of field unflatness. Progress and pitfalls in measuring unflatness at high power are presented. Experiments to determine the cause and to correct unflatness are described. (auth)

50428 USE OF PERIODIC PERMANENT MAGNET FOCUSING IN ELECTRON LINACS. Williams, C. B.; McMillan, J. I. (Gulf Energy and Environmental Systems Co., San Diego, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 619-20(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

In electron linacs, space charge and the radial component of the rf field tend to increase the radius and divergence of the electron beam. These defocusing forces are commonly counteracted by the use of magnetic lens and solenoids. The use of linacs as portable, high energy radiographic sources however necessitates that the weight and power requirements of each component be reduced to a minimum. This has led to the concept of periodic permanent magnet focusing as a replacement for the conventional magnetic lens and solenoids. In this study the conventional copper discs of the waveguide are replaced by a magnetic material which is plated with copper to provide the required resistivity. Permanent magnets are placed around the outside of the accelerating structure to provide a periodic magnet system capable of focusing the injected beam. A computer program has been developed for the iterative solution of the relativistic equations of motion which give the electron trajectories in the periodic field during the acceleration process. The influence of periodicity and axial magnetic field strength on the beam radius and divergence for accelerators operating from 3,000 to 10,000 MHz are discussed. Materials considerations and mechanical design techniques are also discussed. (auth)

50429 SOME PROBLEMS OF LONGITUDINAL BEAM DYNAMICS IN HIGH-ENERGY PROTON LINAC. Murin, B. P.; Bondarev, B. I.; Solov'ev, L. Yu (Radiotechnical Inst., Moscow). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 621-4(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

In a proton linac, a change-over to a shorter-wavelength accelerating field is made at a certain energy (of the order of 100 or 200 MeV). With the wavelength reduced by a factor of n, the phase width of a bunch if scaled to this shorter wavelength becomes expanded by the same factor of n while the longitudinal phase acceptance remains essentially equal to that in the initial, i.e., longer wavelength stage. In view of the rather high beam intensities in modern proton linacs this necessitates that the most careful consideration be given to the problem of beam loss reduction. The requirement of beam loss minimization calls for complementing the classical methods of beam dynamics analysis by the more sophisticated Monte Carlo method of computer modeling to understand better the effect of random perturbations in longitudinal motion on beam parameters. A model is described and discussed and the results reveal that both automatic correction of bunch center of mass position in the phase-space plane and phase-space volume transformation must be provided in a high-energy linac. (auth)

50430 DESIGN OF 30-MeV HIGH-CURRENT LINEAR INDUCTION ELECTRON ACCELERATOR-INJECTOR FOR IBR-2 PULSED REACTOR. Anatskii, A. N.; Alexeev, R. A.; Anan'ev, V. D.; (and others) (Scientific Research Inst. of Electrophysical Apparature, Leningrad. Joint Inst. for Nuclear Research, Dubna, USSR). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 625-7(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The accelerating system, pulse power supply, beam channel, and beam injection into the reactor are described. Basic parameters for the 250-A 30-MeV electron accelerator are given. (W.H.K.)

50431 PANEL ON SUPERCONDUCTING SYNCHROTRONS: INTRODUCTORY REMARKS. Gilbert, William S. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 629-31(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The status of pulse dipole magnet development at Berkeley is briefly outlined. Topics include fine wire developments, model pulse dipole results, and parametric design–cost estimate. (W.H.K.)

50432 COMMENTS ON SUPERCONDUCTING SYNCHROTRONS. Martin, R. L. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 632-3(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Brief comments on superconducting synchrotron development are presented, and a preliminary proposal for replacing the magnet coils in the ZGS with superconducting coils is given. (W.H.K.)

50433 SUPERCONDUCTING SYNCHROTRON MAGNET DEVELOPMENT AT BROOKHAVEN. Sampson, W. B. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 634-5(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A brief review of the superconducting synchrotron magnet development work at Brookhaven National Laboratory is given. Efforts have been directed toward the development of magnets suitable for use in a very high energy slow-cycling machine. The status of the project is outlined. (W.H.K.)

50434 PULSED SUPERCONDUCTING MAGNET WORK AT SACLAY. Bronca, G.; Lefrancois, C.; Perot, J.; Pouillange, J. P. (CEN, Saclay, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 636-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Results of small coils studies and problems in pulsed dipole construction are outlined. (W.H.K.)

50435 SUPERCONDUCTING SYNCHROTRON DEVELOPMENT: NOTES ON RECENT WORK AT THE RUTHERFORD LABORATORY. Smith, Peter F. (Rutherford High Energy Lab., Chilton, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 641(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Topics include theoretical work on self-field effects, coil performance studies, winding accuracy of synchrotron dipoles, and developments in superconducting energy transfer. (W.H.K.)

50436 CRYOPUMPING SYSTEM FOR THE INDIANA UNIVERSITY 200 MeV CYCLOTRON. Herman, H.; Rickey, M. E. (Indiana Univ., Bloomington). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 642-5(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The cryopumping system for the 200 MeV cyclotron being designed and built at Indiana University is described. The volume of the vacuum chamber is approximately 28000 litres (1000 ft^3) and the estimated net area is 3.5×10^6 cm^2. Two flange mounted cryopump assemblies are used to reach a pressure in the low 10^{-6} torr region. Each assembly consists of a 20°K refrigerator which uses ambient temperature helium gas and a chevron radiation shield which uses helium gas in a closed cycle at a nominal 80°K from a cryogenerator. The pumping speed of each pump is in the region of 30000 litres per second for nitrogen at 1×10^{-5} torr or less, plus 250000 litres per second for water vapor. Liquid nitrogen is not used for cooling the radiation shield because of explosion hazards. A cryogenic heat exchanger (part of the closed cycle) in a safe location can be used also with liquid nitrogen for cooling the 80°K helium circuit should the cryogenerator be out of use for more than its scheduled maintenance period. (auth)

50437 LOW COST VACUUM HARDWARE DEVELOPED FOR THE CERN PS BOOSTER. Rufer, C. E.; Unterlerchner, W. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 649-53(Jun 1971).

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From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The vacuum system for the CERN Proton Synchrotron Booster (PSB) is of a rather unique design because it combines four vertically stacked individual accelerators into one single vacuum system. The four rings are pumped simultaneously through 30 manifolds interconnecting the rings. Because of this design and the resulting restrictions in available space and because of the large number of vacuum seals present it has been necessary to develop a system of low cost metal sealed vacuum joints allowing for rapid connection and disconnection. The development of these metal seals and quick clamp connectors together with the special cases of electrically insulated joints with RF bypass is described. (auth)

50438 VACUUM SYSTEM FOR THE NAL BOOSTER SYNCHROTRON. Hubbard, E. L.; Hanson, W. B.; Patel, U. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 654-5(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The design objective for the booster vacuum system was to build in reliability by encasing the magnets in stainless steel and by having only a minimum of gasketed joints. The epoxy-impregnated magnets and coils are, in essence, the high-vacuum envelope; this construction reduces the height of the gap in the magnets and leads to savings in the power supply. Hence, a comprehensive study of suitable epoxies was made to select the best from the standpoint of vacuum and radiation resistance. The outer casing of the magnets has several functions: (1) to provide the necessary structural rigidity to the magnet, (2) to ensure vacuum tightness, and (3) to serve as its own vacuum-impregnation mold. All of the magnets are baked for two weeks before installation in the ring. The vacuum-pumping system consists of one ion pump on each support girder, which carries two magnets, and a turbomolecular pump for roughing each pair of girders. Provision for the addition of sublimation pumps has been made, if operation shows that they are needed in some areas. Most beam-line joints are welded discs that can be readily cut and rewelded, if required. The more-frequently opened joints above the pumps utilize quick-disconnect flanges and metal "C" ring gaskets. The system is in operation, and current data regarding its performance are presented. (auth)

50439 SUPERCONDUCTING 3.5 TESLA, 3 METER PROTOTYPE BENDING MAGNET. Fast, R. W.; Heim, J. R. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 656-9(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A 3.5-tesla, 3-meter long superconducting dipole magnet has been designed, fabricated, and tested as a full-size prototype of a secondary-particle bending element. The magnet has a 10-cm circular aperture that is at room temperature. The coil was fabricated of 1.9-mm square Nb–Ti composite conductor, with strands twisted with a pitch of one cm. The coil was wound so that the field was uniform to within ±1.0% over the aperture. Room-temperature iron surrounding the cryostat enhances the field by 10% and reduces the fringe field to less than 100 G. The design current for the magnet was 700 A at 3.5 T including the iron contribution. The stored energy at 3.5 T is 250 kJ. Experimental data on the two-dimensional field uniformity and the end effects are presented, along with the cool-down and steady-state heat leak data. (auth)

50440 PERFORMANCE OF MULTIFILAMENTARY SUPERCONDUCTING WIRE IN SOLENOIDS AND PROTOTYPE SYNCHROTRON MAGNETS. Sampson, W. B.; Dahl, P. F.; McInturff, A. D.; Robins, K. E. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 660-3(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Superconducting wires containing several hundred very fine (~7 μ) filaments have been tested for stability and energy loss under pulsed field conditions. The wires were produced by several manufacturers and tested in the form of solenoids of various dimensions as well as in the dipole configuration. Results are presented on the performance of high current conductors made from wires which are individually insulated as well as cables bonded with metallic materials to form a monolithic conductor. (auth)

50441 ECONOMICAL CRYOGENIC PULSED SYNCHROTRONS FOR VERY HIGH ENERGIES. Danby, G. T.; Allinger, J. E.; Jackson, J. W. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 685-9(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

For small aperture accelerators, compact "window frame" iron magnets excited to ≥40 kG have desirable features. The fields inside the exciting coil are sufficiently parallel to the aperture field that ribbon coils are practical. The ampere turns required are ~⅓ of an equivalent air core magnet. High purity aluminum is a reasonable candidate for conductor material. Operating at ~10°K hysteretic losses are a small incremental load. The enormous thermal conductivity of high purity aluminum greatly simplifies cooling. The iron also provides a very large thermal flywheel so that refrigerator requirements can be substantially the average heat load. A large model constructed in this manner has been pulsed to 40 kG many thousand times with no degradation in conductor properties. Performance and cost data are presented, based on actual experience. Detailed properties of the aluminum and of the hardware with aluminum and superconducting coils are given. (auth)

50442 CMS, A COLD MAGNET SYNCHROTRON TO UPGRADE THE PROTON ENERGY RANGE OF THE BNL FACILITY. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 694-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A description is presented of a cold magnet synchrotron for a maximum proton energy of 100 GeV (or 150 GeV), making use of very pure aluminum conductor magnets (12°K) or superconducting magnets (4.5°K). Parameters, conceptual designs and unusual features are discussed. (auth)

50443 VACUUM CRYOPUMPING A HEAVY ION SOURCE IN A HIGH VOLTAGE TERMINAL. Wolgast, Richard C. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 699-702(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Two coldfingers differentially cryopump the heavy ion source of the SuperHilac 3-MV injector. One coldfinger near the source freezes most of the source gas load and provides adequate clean vacuum for source operation. The second coldfinger near the beam entrance into the high voltage column produces high vacuum to reduce ion beam loss through charge exchange and accidental electrical discharges. The 20°K temperature is produced by a small refrigerator in the terminal, and is transmitted to the coldfingers by hydrogen-charged heat pipes. The effective system pumping speed for air at the source measures 180 l/s. While running beams of argon ions, pressures are 8×10^{-5} mm Hg at the source and 5×10^{-6} at the column entrance. The integral of pressure with distance along the terminal beam path is 1.8×10^{-3} mm Hg-cm. (auth)

50444 LATTICE AND APERTURE CONSIDERATIONS IN THE COLD MAGNET SYNCHROTRON (CMS). Courant, E. D.; Chasman, R. W.; van Steenbergen, A. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 707-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

With either superconducting or cold aluminum coils the optimum design of bending magnets for a synchrotron tends to have approximately equal horizontal and vertical apertures. It is therefore advantageous to tailor the lattice and beam parameters so that horizontal and vertical requirements are equal; this imposes the severest constraints on the horizontal aperture, and the vertical tune ν_z may be allowed to be less than ν_x. A lattice has been designed with 48 focusing periods, six magnet superperiods each containing an 8-m straight section, $\nu_z = 7\frac{1}{3}$, $\nu_x = 10.45$. This choice avoids low-order superperiod resonances and facilitates resonant vertical beam extraction. With 30 GeV injection from the AGS, a gross semiaperture of 20 mm accommodates all requirements, provided field error corrections are obtained from beam position measurements. (auth)

50445 CONTROL SYSTEM FOR THE TURBOMOLECULAR PUMPING STATIONS AND SECTOR VALVES OF THE CERN INTERSECTING STORAGE RINGS. Groebner, O. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 709-10(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The turbomolecular pumping stations of the ISR ultra-high vacuum system form an operational unit, together with the sector

and roughing valves. The different modes of operation as well as the basic design requirements leading to the final concept of the control system are discussed. Special emphasis is put on the interlock conditions for the sector valves, such as vacuum pressures and the intense stacked proton beam. (auth)

50446 PROPOSED HIGH PERFORMANCE REFRIGERATION CYCLES TO OBTAIN SUPERCONDUCTING OPERATION OF A TWO-MILE LINEAR ACCELERATOR AT 1.85 K, 1.425 K, OR 1.0 K. Hall, F. F. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 711-15(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The existing two-mile linear electron accelerator at SLAC has a duty cycle of less than 0.1% and is limited to 20 GeV. If it were converted to superconducting operation, the duty cycles might be 100% at 20 GeV and 6% at 100 GeV. High performance refrigeration cycles that are necessary to make superconducting operation of the two-mile linear accelerator most reliable and least costly are discussed. (auth)

50447 AGS MAGNET TRANSPORTER. Halik, E. E. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 718-22(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The transporter is in the form of a pedestal base, electrohydraulically powered to cycle automatically while moving the load in a step-like manner. The carrying capacity of this machine is 150 tons. It is designed to transport and position large magnets in the X, Y, and Z axes. It also provides 360° rotation of the load in the Z axis. Movement may be manually controlled or fully automatic at either low or relatively high speed. It positions magnets with a precision of 0.010-in. The unit weighs a little over 10 tons and depends for its power on one 10 hp motor that drives the pumps of a very compact hydraulic system. Carrying range of the transporter is limited only by the length of the 440 V cable that supplies electrical power, and by the carrying capacity of the floor on which it travels. The most progressive anti-friction devices including hydrostatic oil thrust bearings, unique 35-in. diameter hydrostatic journal bearing, air bearings and linear motion roller bearings were employed. This device is being used successfully in the BNL experimental area and has proved to be an excellent time, and therefore, money saver. (auth)

50448 APPLICATION OF A SUPERCONDUCTING SOLENOID FOR THE SIN STOPPED μ CHANNEL PROJECT. Petitjean, Claude; Vecsey, Georg (Swiss Inst. for Nuclear Research, Zurich). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 723-7(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A high intensity μ channel system has been designed for the SIN meson factory at Zurich. Pions of well defined momentum (~200 MeV/c) are injected into a 10 m long 50 kGauss-solenoid (R_i = 7 cm). Muons from π decay in flight are trapped by the magnetic field to almost 100%. A high purity muon beam is obtained by analyzing and focusing the pion free backward decay muons (~110 MeV/c) into the secondary target. The π and μ spectra have been calculated using the Monte Carlo method. The useful muon flux at SIN is expected to be 4.10^8 μ^-/MeV/c sec. The overall μ capture efficiency is 19% and the average μ stopping density 2.10^5/g sec. It is shown that a superconducting solenoid produces a 3 times higher muon density in phase space than a conventional quadrupole channel. A special low momentum operation mode is proposed for bent crystal spectrometers, where the μ stopping density is about 10 times enlarged by placing the μ target into the solenoid exit. (auth)

50449 EXTERNAL PROTON BEAM TUNE CALCULATIONS INCLUDING TARGETS AT CONSECUTIVE FOCII. Concaildi, G.; George, R.; Marcowitz, S.; Nielsen, R.; Wehrle, R. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 728-31(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A beam transport program for the CDC-924A ZGS control computer has been prepared which includes the change in phase space properties caused by multiple scattering in target material at the various consecutive experimental user stations (focii). The beam envelope, continuous across targets, can be displayed on an oscilloscope and the beam parameters can be adjusted to fit desired conditions. The phase space ellipse at any specified position in the beam can also be displayed. Average energy loss is included in the computations to update the beam momentum. Experimental tests will be made to determine the validity of the computations. (auth)

50450 GAS COOLING FOR THE PION PRODUCTION TARGET AT SIN. Tschalaer, C.; Schwedtmann, K. A. (Swiss Inst. for Nuclear Research, Zurich). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 732-3(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A concept for cooling of the pion production target at SIN with helium gas at 20 atm was investigated. A 590-MeV proton beam of 100 μA will deposit 5 kW in a graphite or beryllium target of 120 mm length and a diameter of 6 to 10 mm. Longitudinal cooling fins provide target surfaces of 80 to 130 cm^2. Detailed calculations show that heat transfer values of up to 1.0 Wcm^{-2} deg^{-1} may be obtained with gas velocities of 200 to 400 m/sec and pressure losses of 10%. Heat transfer tests are currently under way. The advantages of gas cooling are: (a) the very small masses of the gas and gas vessels surround the target providing a well defined pion source geometry, (b) no handling of highly radioactive water, and (c) no corrosion of the cooling system. The disadvantage is the relatively expensive helium blower. (auth)

50451 BROOKHAVEN AGS RADIATION MONITORING SYSTEMS. Levine, G. S.; Bennett, G. W. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 734-5(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Radiation monitoring systems are described which provide digital information on the location and temporal distribution of radiation in the AGS ring and along an external beam line. Ionization chambers, symmetrically placed, convert absorbed radiation into pulse information which is passively transmitted to the control room, where it is displayed as the data is produced, is recorded permanently, and is available for counting, monitoring, and use in control circuits. A unique binary display of intensity at each location as it occurs during the accelerator cycle provides an easily comprehended picture of the radiation losses. A beam loss detection system for the Slow External is described. A self checking, redundant scheme is employed for personnel protection against excessive radiation levels arising outside a beam line shield which is only adequate for normal transport losses. Studies concerned with enhancing the detectors insensitivity to radiation damage and measurements of detector response are outlined. Limitations, operational experience, and utility in machine performance are discussed. (auth)

50452 UNDERGROUND WATER LEACHING OF RADIONUCLIDES PRODUCED IN SOIL BY HADRONS CREATED IN HIGH ENERGY PROTON INTERACTIONS. Awschalom, M. (National Accelerator Lab., Batavia, Ill.); Borak, T. B.; Fairman, W.; (and others). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 739-40(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Soil samples collected from the NAL construction site were irradiated downstream from Target stations at the Argonne National Laboratory ZGS and Brookhaven National Laboratory AGS. Radiochemical analyses were performed to determine the radioactivities induced in the soil. Batch-type leaching experiments were then conducted to determine the distribution of the induced radionuclides between the soil and water. Of the radionuclides produced in the soil, only ^{3}H, ^{22}Na, ^{45}Ca and ^{54}Mn were detected in the leach waters. The results were used to determine possible contamination of underground reservoirs. (auth)

50453 DESIGN OF PENETRATIONS IN HADRON SHIELDS. Gollon, P. J.; Awschalom, M. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 741-5(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The use of the neutron albedo concept is one method of calculating the neutron leakage through a penetration such as a labyrinth in a hadron shield. The Monte Carlo program ZEUS ALB.5, which incorporates the neutron albedo data of Maerker and Muckenthaler, was modified and used for systematic studies of labyrinth design. Factors studied included variations in the aspect ratio (height/width) of the penetrations, placement and depth of cul-de-sacs, curved sections, etc. Results are presented in graphical form to allow easy estimation of neutron-dose attenuation for various geometries. Comparisons are made between calculations and experiment. (auth)

50454 NOVEL INSTRUMENTATION FOR RADIATION MONITORING AT NAL. Awschalom, M.; Borak, T.; Howe, H.; (and others) (National Accelerator Lab., Batavia, Ill.). IEEE (Inst.

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Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 748-9 (Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

New types of radiation-monitoring instruments have been developed to help implement the radiation-safety policy adopted at NAL. For monitoring personnel-occupied areas during beam-on conditions, gamma-insensitive neutron detectors were designed using a pair of GM tubes with and without a silver-foil wrapping inside a polyethylene moderator. Displays include a color-coded dose-rate and occupation-time meter display, flashing lights, a dose integrator and an audio alarm. For monitoring and classifying radioactive materials by their activity, well-mounted GM units were built with a color-keyed meter display and lights. Also, inexpensive beam-loss monitors for use in beam areas during operation are described. It may be used to predict acceptably well beam-off radioactivity levels by measuring beam-on radiation levels. (auth)

50455 MUON SHIELDING CALCULATIONS FOR 200-GeV PROTON INTERACTIONS. Theriot, D.; Lee, K.; Awschalom, M. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 750-2 (Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

With the advent of a new generation of high-energy and high-intensity accelerators such as the one being built at the National Accelerator Laboratory and the one proposed by CERN, the problem of shielding in experimental areas becomes quite a massive and expensive project. In addition to the massive hadron shielding required for the high-intensity, high-energy muons produced by the decay of high-energy pions add large amounts of shielding especially in the longitudinal dimension. Homogeneous shields can be designed with programs which have been developed for NAL. In addition, computer programs for the design of heterogeneous shields with voids and/or magnetic fields have been developed. Applications of these programs are discussed. (auth)

50456 MUON SHIELDING FOR A 500-GeV NEUTRINO FACILITY. Kang, Y. W. (National Accelerator Lab., Batavia, Ill.); Roberts, A.; Theriot, D.; Meyer, S. L. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 753-4(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The explicit problem considered is the "shape" of muon shielding for a stopping 500-GeV proton beam. Muon-transport computer programs have been developed for NAL. Results of such a calculation for a neutrino facility show that an earth shield of 1100 meters in length and 7 meters in radius is necessary to permit the use of a bubble-chamber detector with 500-GeV protons. A new calculational method for estimating quantitatively the effect of a magnetized-iron deflector is proposed which shows that a magnetized iron block 1.5 meters in radius and capable of deflecting the incident muon flux 22 mrad may permit the use of a shield adequate for bubble chambers as short as 550 meters of earth at 500-GeV. (auth)

50457 WIDE BAND NEUTRINO BEAMS WITH QUADRUPOLE FOCUSING. Carey, D. C.; Stefanski, R. J.; Teng, L. C. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 755-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

For high-energy neutrino beams, the requirements of large solid-angle acceptance and wide bandpass can be achieved with a focusing channel composed of quadrupole cells, where each cell is sequentially scaled in aperture, length, and field gradient. A formalism for the design of these quadrupole focused neutrino beams with wide bandpass has been developed. The theory is presented and the results of calculations are given for some quadrupole-focused neutrino beams. Compared with more exotic focusing techniques, quadrupoles offer inherent reliability and easy maintenance. The system, which can be used in either long- or short-spill operation, can also be used as the front end of a muon beam for a facility that would be shared between neutrino and muon experiments. The quadrupole focusing channel does not, however, distinguish between parent particle charges and therefore cannot produce a pure neutrino or antineutrino beam. (auth)

50458 MONOENERGETIC NEUTRINO BEAM USING CURRENT-SHEET FOCUSING ELEMENTS. Nezrick, Frank A. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 759-60(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Current-sheet focusing elements (horns, fingers, etc.) are presently being used at accelerators to produce broad momentum-band-pass neutrino beams. A system composed of two special horns and a collimator is described that produces a helicity and momentum-selected neutrino beam of high purity. Other advantages of this system are the small physical size, low power requirement, and simple design of the focusing elements. This focusing system is ideally suited to produce monoenergetic neutrino beams with energies below about 70 GeV. (auth)

50459 USE OF RADIATION SENSITIVE MATERIALS ON HIGH POWER ACCELERATORS. Hill, G.; Laukant, E.; Sheldon, R.; Stapleton, G. B. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 761-3(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The environment around accelerators having high beam currents, with particular reference to the problems likely to be encountered around accelerators having energies in the 100-GeV range, are discussed. A review of the materials used in the construction of the 500-GeV accelerator at the National Accelerator Laboratory is made with indications of their stability and possible life. In particular, materials used in components close to the beam are considered, and the compromises that have been made to allow a pragmatic approach to accelerator building are discussed. (auth)

50460 LONG PULSE SYNCHRONOUS TRAVELING WAVE SEPARATOR. Chang, C. T. M.; Dawson, J. W.; Fuja, R. E.; (and others) (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 764-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A synchronous traveling wave separator employing two sections of partially dielectric filled deflectors is being developed at Argonne for 1.5 to 2.5 GeV/c K^- experiments on the 12-ft bubble chamber. The two deflectors are fed serially from one klystron and are separated by a drift space. The relative phase between them is adjusted to yield maximum deflection for the wanted particles. The klystron operates at 1.25 to 1.35 GHz with a modulated pulse of 54 μsec from a delay line type modulator at 2 pulses/second with 5 MW peak power. The results of high power tests conducted in a rectangular deflector at 2.856 GHz show that field levels of more than 2.5 times the present maximum operating level have been achieved. The construction of circular and rectangular deflectors and the input/output coupler is discussed. Since the deflection efficiency of these structures is between 0.34 and 0.45, they are considered more attractive for 1 to 5 GeV/c kaon beams. (auth)

50461 LONG PULSE, HIGH POWER TEST OF ARGONNE'S RF SEPARATOR DEFLECTOR STRUCTURES. Dawson, J. W.; Moretti, A.; Peerson, J. J.; Rebuehr, M. T. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 769-70(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A program is underway at Argonne National Laboratory (ANL) to develop a long pulse rf separated beam for the 12-foot bubble chamber. For effective operation of this beam, the rf separator structure must support a minimum rf input power of 4 MW for a pulse length of 50 μsec without arcing or breakdown. The first ANL separator structure (fabricated by Thomson-CSF, Inc., France) has been tested and was operated to 6 MW for 50 μsec pulses without damage. Details of the method of testing, the test system, and test results are presented. (auth)

50462 DRIFT TUBE TECHNIQUES FOR ACTIVE SEMICONDUCTOR TESTING IN THE ELECTRON BEAM OF THE FIELD EMISSION 705 FLASH X-RAY MACHINE. Alexander, D. R.; Hoffland, A. H. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 771-3(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

An evacuated drift tube has been designed and fabricated which enables the experimentor to use the electron beam of a 2 MeV flash X-ray machine for active, low noise irradiations of semiconductor devices. Design details of the drift tube and the dose levels available as a function of tube parameters are given. (auth)

50463 METHOD FOR OPERATING AN IRIS LOADED RF SEPARATOR STRUCTURE AT LOW MOMENTUM. Moretti, Alfred (Argonne National Lab., Ill.). IEEE (Inst. Elec Electron. Eng.), Trans Nucl. Sci.; NS-18: No. 3, 774-5(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

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Because iris loaded separator structures can be operated at phase velocities other than c, it is possible to develop "low" momentum RF separated beams using iris loaded deflectors. A "low" momentum RF beam separator using two iris loaded deflectors is described. This is accomplished by adjusting the RF phase velocity to be in synchronism with the wanted particles. The wanted particles thus receive large deflections. The unwanted particles, because they undergo large phase slips in passing through the deflector, receive small deflections. (auth)

50464 STUDY OF A UNIFORM STEEL BEAM STOP AT 28 GeV. Bennett, G. W. (Brookhaven National Lab., Upton, N. Y.); Foelsche, H.; Lazarus, D.; (and others). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 776-7(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Preliminary data for the distribution of the hadron cascade and of muons in a 36 ft long steel beam stop are presented. The strongly interacting flux was mapped to an axial depth of 16 ft using carbon-11 activation. The muon flux was detected at depths greater than 10 ft by a coincidence technique where the counters were separated by from 2 to 12 ft of steel. (auth)

50465 FLUX ATTENUATION IN A STEEL SIDE SHIELD AT THE AGS. Bennett, G. W.; Foelsche, H.; Lazarus, D.; (and others) (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 778-9(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The shielding properties of steel were studied using an array of steel blocks near a target in the external beam of the AGS. Polyethylene foil detectors for ^{11}C activation were used as beam monitors as well as to measure the flux distribution in the steel. Flux measurements were made on the face of the shield (10 in. from the beam axis) and at various locations in the array to a depth of 38 in. from the beam axis. In analyzing these results it is apparent that the usual models of exponential attenuation of flux with distance in the shield are unsuitable. A striking regularity is present; the ratio of radial distances from the target to isoflux lines is constant, independent of angle. (auth)

50466 FAST NEUTRON CANCER THERAPY WITH THE TAMVEC. McFarlin, W. A.; Suttle, A. D. Jr. (Texas A and M Univ., College Station). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 780-3(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The applicability of high current, medium energy, variable energy cyclotrons to the production of fast neutrons for human cancer therapy is discussed. General medical concepts and therapy requirements relating to facility modification, patient handling and fast neutron beam collimation are presented. A summary is given to review the work to date at TAMVEC on cellular radiobiology, small and large animal radiobiology, fast neutron dosimetry, collimator design, and the development of useable fast neutron beams using 16 MeV, 30 MeV and 60 MeV deuterons incident on beryllium targets of different thicknesses. The details of a proposal by the M. D. Anderson Hospital and Tumor Institute of the University of Texas, in collaboration with Texas A&M University, for the establishment of a three phase fast neutron human cancer therapy program at TAMVEC are discussed. (auth)

50467 TAMVEC MODE SELECTION SYSTEM. McCann, D. G. (Texas A and M Univ., College Station). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 782-3 (Jun 1971).

From National particle accelerator conference: Chicago, Ill. (1 Mar 1971). See CONF-710308.

The basic concept in the design of the TAMVEC beam line selector (mode) switching system is discussed. A description of the beam line logic sequence and circuitry illustrate the flexibility in control of beam line equipment and the built-in features for protection of personnel and equipment. Application of the mode switching concept to the automatic sequencing of six, 9 KW dual-quadrupole power supplies for powering thirteen quadrupole doublets with full polarity reversal is presented. The design of an inexpensive and reliable 2500 ampere polarity reversal switch and its use in twenty-five high current power supplies is discussed. (auth)

50468 INVESTIGATION OF SOLID STATE PREAMPLIFIER-DETECTION DESIGN FOR THE BNL 200 MeV LINAC RADIATION SYSTEM. Pyros, Icarus (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 786(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A digital neutron detection system is being implemented as a machine security system for the 200 MeV Linac. The system will detect neutron activity above some predetermined threshold which in turn will rapidly abort the initial source of protons. (auth)

50469 DESIGN OF SECONDARY BEAM CHANNELS FOR THE NEVIS SYNCHROCYCLOTRON CONVERSION PROGRAM. Holland, M. M.; Brennan, J. M.; Cohen, R. C.; Hammerman, I. S.; Martin, E. J. (Columbia Univ., New York). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 787-91(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The modification program includes the design of two pion channels characterized by $0 \leq P_o \leq 250$ MeV/c with $\pm 1\% \leq \Delta P/P_o \leq \pm 10\%$ and $200 \leq P_o \leq 400$ MeV/c with $\Delta P/P_o \simeq \pm 1\%$ and a stopped muon channel with low contamination and average polarization $\geq 75\%$. Two computer programs instrumental in their design are described. BARTELBE utilizes a function minimizing code in conjunction with first order beam optics to simultaneously optimize any number of desired conditions relating to desired optical system and momentum resolution, and a beam acceptance volume. MAGSYS is a Monte Carlo code which generates each pion according to given input parameters and follows its history through a system. In the output are detailed pion and muon beam profiles and muon polarization. (auth)

50470 PRECISION ACTUATOR AND SHAFT ENCODER FOR A HIGH RADIATION ENVIRONMENT AND OTHER BEAM COMPONENT DEVELOPMENTS AT SLAC. Lucas, L. R.; Walz, D. R. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 792-4(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A precision actuator and shaft encoder combination for remote handling in a high radiation and corrosive environment was developed. The package allows accurate positioning of beam transport components in areas where liquid lubrication is not possible. The actuator translates rotary motion and torque supplied by a motor into linear motion and force. It can be called a "double linear harmonic drive" where the flexing sleeve drives two cylinders with annular grooves. The use of hexagonal lattice metals prevents galling or seizing of the rolling surfaces and wear is small for dry, unlubricated operation. The actuator and encoder are coupled to a commercial radiation-resistant stepping motor. The encoder resolves the turns of the motor in 1024 increments with cams and microswitches. The existing actuators have a 3" output travel. Reproducibility is to ±1 step or 0.0006". The mechanical output has zero backlash. The actuator and encoder are discussed and illustrated, including performance data. Also a new quick-disconnect injected indium vacuum seal and a safety feature developed for the beam stoppers of the SLAC personnel protection system are described. The instrument responds to thermal radiation and does not depend on electronics. (auth)

50471 LARGE COST REDUCTIONS MADE POSSIBLE BY RE-EVALUATION OF BEAM TRANSPORT PARAMETERS. Allinger, J. E.; Danby, G. T.; Jackson, J. W.; Smith, L. W. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 797-801(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A detailed study of beam transport hardware for external beams has recently been completed. This study was made from the viewpoint of reducing capital and operating costs of beam components, which could result in a greater number of high quality beams for a given amount of money. (auth)

50472 HIGH YIELD, LONG-LIVED TRITIUM TARGETS. Haywood, F. F. (Oak Ridge National Lab., Tenn.); Banta, H. E.; Burson, Z. G. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 802-3(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

In order to extend the lifetime of conventional nonrotating tritium targets (say, TiT_2), a new design concept for neutron generator targets has been tested successfully. It consists of a device which allows the target area to be replenished during operation. It has been used to produce neutrons [T(d,n)^{4}He reaction] for about ten hours at a sustained 4π yield of 2 to 4×10^{10} n/mA-s Tritium diffuses through a palladium foil into the target area when the foil is heated by a deuteron beam. Control of the flow of tritium is accomplished by regulating

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the gas pressure in the reservoir and water flow in the cooling system. (auth)

50473 MAGNETIC ELECTRON DEFLECTION TUBE. Phillips, D. H.; Grannemann, W. W.; Dunham, D. E. (Univ. of New Mexico, Albuquerque). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 804-5(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The deflection tube described is used to harden the electron output spectrum of the Febetron 705 Flash X-ray (FXR) machine. The deflection tube is intended for use when performing electron-beam transient radiation effects on electronics (TREE) experiments. High-energy-electron dose rates in silicon are variable from 10^9 to 3×10^{10} rads(Si)/sec. A magnet is used to deflect all low-energy ($E < 0.5$ MeV) electrons out of the horizontal electron beam. The remaining high-energy electron spectrum can be used to irradiate test samples with more uniform dose-depth profiles in the test sample. More than 99.9 percent of the electrons are returned to the FXR machine via the deflection tube walls, thereby satisfying an operational requirement of the Febetron. (auth)

50474 HYDROGEN TARGETS AT SLAC. Mark, John W.; Pierce, William B. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 806-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Many liquid hydrogen targets at SLAC are now multiple assemblies that allow the user to select liquid hydrogen, liquid deuterium, or any of several solid targets. The most elaborate assembly built to date has a cell with circulating liquid hydrogen, a cell with circulating liquid deuterium, and an array of 9 solid targets or holes. The target in use is selected by the computer. Target position is determined by encoders and verified by microswitches. Forced circulation of hydrogen is used in other targets where the heat load is too high to allow stable operation with natural convection. One target is used in a streamer chamber environment. Multi-layer insulation is not desirable, and the length-to-diameter ratio is more than 100. (auth)

50475 EXPERIMENTS WITH MEGAGAUSS TARGETS AT SLAC. Herlach, F. (Illinois Inst. of Tech., Chicago); McBroom, R.; Erber, T.; Murray, J.; Gearhart, R. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 809-13(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The high pressures and current densities associated with MG fields limit their useful lifetime to 1 μsec or less. The pulse duration of the SLAC electron beam being of the same order of magnitude, a successful marriage of the two techniques was achieved in experiments that use transverse fields in the range 1 to 2 MG as targets for a 19 GeV electron beam. The fields were generated in volumes of dia 3 to 5 mm by discharging a very fast capacitor bank into small single turn coils, or by flux compression with electromagnetically driven aluminum foils. The termination of the capacitor bank, designed to minimize the destructive effects of the exploding coils, permitted a repetition rate of one shot per hour. Magnetic bremsstrahlung emitted by the electrons was recorded on X-ray film and nuclear emulsions. In an additional experiment, nuclear emulsions mounted in the high field region survived the violent self-destruction of the coils. In these, the magnetic deflection by far exceeds the multiple scattering, which is normally the dominant effect in nuclear emulsions. (auth)

50476 BEAM PLUG FOR RADIATION SHIELDING PENETRATIONS. Manni, M. A.; Minati, K. F. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 814-15(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A beam line plug has been designed to fill the cylindrical hole formed by beam lines which pass through radiation shielding walls. The plug consists of multiple steel discs held together along their cylindrical axis by a steel cable forming a flexible snake-like structure. Other disc materials including laminates may be used to solve a variety of radiation shielding problems. When the beam line is to be used the plug is pneumatically withdrawn into a vertical extension of vacuum line that is connected through a 90° bend to the beam line. Upon release, the plug is reinserted by pneumatic action. The beam plugs being used at the Brookhaven Three-stage MP Tandem Van de Graaff Facility are 7.6 cm diameter and provide 80 cm equivalent thickness of steel to fill penetrations through a 120 cm thick concrete wall. Fast-neutron measurements at the shielding wall surface show that the beam plug is indistinguishable from concrete shielding. A description of the beam plug mechanism, failsafe features, test results, and performance data is presented. (auth)

50477 BROOKHAVEN TANDEM FACILITY RADIATION SAFETY SYSTEM. Larson, J. D.; Rogers, P. C.; Schwender, G. E. (Brookhaven National Lab., Upton N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 816-20 (Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A system of personnel protection has been developed for the Brookhaven Tandem Accelerator Facility which imposes a minimum of inconvenience upon the experimentalist. The amount of required security (and attendant restriction on personnel) is kept commensurate with the potential radiation exposure and does not seriously interfere with nonhazardous modes of operation. Radiation areas are divided into zones which permit selective access into low-risk areas. Personnel are excluded from radiation areas on a zone-by-zone basis as the radiation intensity rises. A perimeter consisting of zones and additional barriers surrounding the entire radiation area provides secondary protection against unauthorized access regardless of radiation levels. Violation of the perimeter causes the ion beam to be intercepted before it enters the accelerator. Violation of a high-radiation zone causes shutdown of the accelerator. (auth)

50478 CALCULATIONS OF SHIELDING FOR LARGE CYCLOTRONS. Braid, T. H. (Argonne National Lab., Ill.); Rapids, R. F.; Siemssen, R. H.; Tippie, J. W.; O'Brien, K. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 821-4(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The neutron shielding required for proton accelerators with energies ≤400 MeV is calculated by a convenient and realistic approximation procedure, and is illustrated for the case of a copper target. (auth)

50479 BEAM-SPILL MONITOR FOR LAMPF. Parker, J. R.; Richardson, J. H.; Oetting, J. D.; Easley, J. D. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 825-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A liquid-scintillator radiation detector and associated electronics have been developed to serve as a beam-spill monitor at the Los Alamos Meson Physics Facility (LAMPF). Over 50 of these detectors will be required; hence, low cost per unit has been an important consideration in its development. This and additional requirements of fast action, reliability, and a sensitivity that can be varied by over 1000:1 have been met. The detector, simply a 931-type multiplier tube immersed in a mineral oil scintillator, has a useful range from 10^{-3} to 5×10^5 R/h. The electronics consist of a threshold detector, fast switch, peak detector, and log converter. The manner in which these interface with the LAMFP fast protect system and the analog and binary inputs to the control computer is described. (auth)

50480 OPERATING EXPERIENCE WITH HIGH POWER BEAM ABSORBERS IN THE SLAC BEAM SWITCHYARD. Reupke, W. A.; Walz, D. R. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 827-31(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

In four years of operation at progressively increasing levels of average power new observations on the performance of slits, collimators, and beam dumps of various designs have been accumulated. The inherent longevity of high power beam absorbers based on low-Z or graded-Z design philosophy has been successfully demonstrated. The performance of multiple protective interlock circuitry is described and system response patterns are given. Two types of beam line failures are discussed: The air burst resulting from the melting of soft-metal vacuum seals and stainless steel transport pipes at modest power densities; and the water burst resulting from the failure of heat transfer surfaces at high power densities. Problems of beam line restoration in a radiation environment are briefly discussed. Downtime to date attending beam-induced failure of the vacuum envelope has been of the order of 350 hours, averages less than 10 hours per event, and accounts for some 15% of the unscheduled downtime from all sources combined. (auth)

50481 CALCULATION OF A PARTICLE ANALYSER FOR AN 80 MeV ISOCHRONOUS CYCLOTRON. Gersch, H. U. (Joint Inst. for Nuclear Research, Dubna, USSR). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 832-4(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A particle analyzer with a 50,000 momentum resolution which allows to pass the whole accelerator emittance (3π mm · mrad

radial, $6\pi \cdot$mm mrad axial) has been calculated. The necessary dispersion ($D \simeq 35$ m at slit widths of 0.75 mm) is produced by two 170° magnets with $\rho_0 = 1.5$ m and $n = 0.8$ (opposite deflection direction) and four quadrupole lenses. Practical fringing fields for the magnets (Rogowsky-field) and lenses are used in the optimization of the second order aberration and apertures. Thus, the spreading of the particle beam by the second order effects at the exit slit is of about 2 mm. The admissible tolerances of the employed parameters are discussed. The analyzing system is also usable as an achromat and an analyzer with a mean dispersion. (auth)

50482 RAY TRACING CALCULATIONS ACCORDING TO FIELD MAPPING FOR THE JUELICH DOUBLE MONOCHROMATOR. Reich, J.; Martin, S.; Mayer-Boericke, C. (Institut fuer Kernphysik, Juelich, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 835-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The fields of the magnets of the double monochromator for the Juelich isochronous cyclotron are mapped in the region of $390 < B\rho < 2040$ (kG · cm). The data are fed into a processing program which prepares the data for the ray tracing program TRARA and calculates the parameters for the program TRANSPORT. Tracing the central ray through the system with TRARA the fields of the analyzing magnets are set to give the precise angles of bend for a chosen momentum. A bundle of rays representing the phace space at the object slit is traced through. TRARA calculates from their coordinates at desired positions in the system a whole set of coefficients of sufficiently high order. They are used to calculate the resolution power of the system with a more dense bundle. The results are compared with calculations made with the second order coefficients of TRANSPORT. (auth)

50483 RAPID CYCLING FLAT-TOPPED SYNCHROTRON MAGNET SYSTEM. Huttar, D. E.; Cheeseman, P. R. (Princeton Univ., N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 839-44(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The Princeton-Pennsylvania Accelerator (PPA), operating as a rapid cycling synchrotron at 19 Hz, produces an intense beam with a spill duty factor of 18% or less. The beam has the "RF structure" characteristic of PPA but also the energy modulation associated with the variation in magnetic field during an extended spill. Some years ago, a plan was formulated to provide a flat top to the magnet field waveform with a duty factor as high as 50%. This plan took advantage of the distributed nature of the magnet circuit which results in modest voltage stress on the individual components. Even so, implementation of the plan required the development of a 5kV rms, 1000A rms electronic switch. Also, static power supplies were required to replace the existing rotating machinery. Fairly sophisticated measures were required to regulate the magnet current during flat-top and to cope with the rather nasty transmission line modes of the circuit. The program has been essentially completed. Termination of the facility operating contract has prevented the actual use of the equipment for experimental purposes but all significant goals have been met and the completed system and its performance are described. (auth)

50484 COMPUTER METHOD FOR THE ANALYSIS OF AXISYMMETRICAL MAGNETIC FIELDS FOR AN ACCELERATOR. Kumagai, Michikazu (Tokyo Shibaura Electric Co., Ltd., Kawasaki, Japan). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 845-7(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A computer code has been set up for use in calculating the magnetic field distribution for a circulator accelerator. The code calculates axisymmetrical three-dimensional magnetostatic fields, including the effect of coil current distribution. The modified scalar potential for axisymmetrical fields is derived to solve the boundary value problem of Poisson's equation. Magnetic fields for betatron poles have been computed. The results are in agreement with measurements. (auth)

50485 MAGNET PROFILE DESIGN. Snowdon, Stanley C. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 848-52(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Transformations of a complex variable have been used by several authors to generate magnet pole contours. The work reported here is restricted to multipole magnets but includes modifications of previous transformations that allow current carrying elements, a plane of symmetry, and a return yoke to be introduced. Application is made to dipole, quadrupole, and sextupole magnets. An extension of the method provides for a rectilinear dipole. (auth)

50486 BENDING MAGNETS OF THE NAL MAIN ACCELERATOR. Hinterberger, H.; Satti, J.; Schmidt, C.; Sheldon, R.; Yamada, R. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 853-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Two types of bending magnets of simple construction are used in the main accelerator: one with a 1½-in. by 5-in. vacuum pipe aperture, and the other with a 2-in. by 4-in. aperture. Both magnets are about 20 feet long and weigh about 13 tons. Mechanical characteristics of these magnets are discussed, including water-flow rate and temperature rise. Magnetic characteristics of about 800 bending magnets have been measured. Data on the variation of magnetic length at remanent field and various excitations are presented. They are discussed with the variations in mechanical length, back-leg gap, and other effects. A comparison of calculated (using TRIM program) and measured magnetic-field distribution is made. The effect of the vacuum chamber on the magnetic field due to eddy currents and finite permeability is discussed. (auth)

50487 QUADRUPOLE MAGNETS OF THE NAL MAIN ACCELERATOR. Hinterberger, H.; Pruss, S.; Satti, J.; (and others) (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 857-9(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The quadrupole magnet contains several interesting design features, among which are a useful gap which is asymmetrical between horizontal and vertical, a very simple coil design, location of the coils near the useful gap, and small gradient error up to high pole-tip fields. The design has been worked out with the relaxation program LINDA. Magnetic measurements on the production magnets are presented and compared with the design values. In the process of making these measurements, new techniques were developed for finding the gradient error as a function of position and the effective center, both integrated over length. Also presented are the results of measurements of the effective-length uniformity, the structural properties, and the effectiveness of the water-cooling circuit. (auth)

50488 POWER SUPPLY SYSTEM, CONTROL, AND RESPONSE OF THE NAL MAIN ACCELERATOR. Cassel, R.; Pfeffer, H. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 860-3(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The programmed power-supply system of the NAL main accelerator is described. The arrangement of individual power supplies with respect to the magnet system as well as a detailed description of the individual power-supply configuration, protection, and control are discussed. The propagation of transmission-line modes of the magnet system, including the spatial distribution of field errors due to the power-supply arrangement and control, is discussed. The overall control-system programming, current monitoring, and feedback used to obtain the overall field regulation are also discussed. (auth)

50489 USE OF SUBSURFACE VOIDS FOR OFFSETTING SATURATION EFFECTS IN QUADRUPOLE MAGNETS. Schivell, J.; Schmidt, C. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 864 (Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The quadrupole magnets in the NAL main accelerator are required to run at very high pole-tip fields: 10 kG at the 45° point on the pole, and 21 kG at the horizontal extremities of the aperture. The design has been successful. However, inasmuch as it is desirable to be able to operate the magnets at a 25% higher field level, methods were investigated for maintaining the width of the useful aperture even at such a high magnetic field. It was found that introducing voids in the iron of the pole tip could compensate for the saturation of the edges of the pole, without disturbing the good field at lower levels of excitation. (auth)

50490 INEXPENSIVE, LARGE BANDWIDTH, PRECISION D. C. CURRENT TRANSFORMER FOR STABILISED MAGNET POWER SUPPLIES. Fry, Michael G. J. (Brentford Electric Ltd., Crawley, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS;18: No. 3, 865-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The Brentford/Hingorani D. C. current transformer gives trans-

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formation ratio errors no larger than those of a good zero flux, 2nd harmonic modulator type current comparator, but at considerably lower cost and with larger bandwidth (for pulsed supplies). While based on the Kraemer series-connected transductor, a minor circuit modification eliminates the magnetic uncoupling of primary and secondary windings inherent in the Kraemer principle due to simultaneous saturation of both cores. Elimination of this prime error source produces half-hour stabilities better than 100 p.p.m. Analysis of 2nd and 3rd order errors shows that with simple means these errors may be reduced to a few p.p.m. A description of the instruments used for the beam transfer line power supplies on the I.S.R. project at CERN is presented. (auth)

50491 80 kG-FOOT BEAM SWITCHING MAGNET AND ITS PULSED CURRENT SUPPLY. Praeg, Walter F. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 871-2(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A switching magnet system has been developed for deflecting the external proton beam of the Zero Gradient Synchrotron to a bubble chamber beam line. The field in the 4-inch gap of the 14.3-ton air cooled magnet reaches a flattop value of 15.5 kG in 14 msec and remains constant for 5 msec. A 13 kV, 100 kJ capacitor bank provides the pulse energy. The flattop is maintained either by a low voltage capacitor bank or by a power amplifier in a feedback loop excited by a B coil and driving magnet pole face windings. The discharge circuit oscillates for little more than one-half cycle. Since 96% of the pulse energy is returned to the capacitor bank, only 3.6 kW average power is required to pulse the magnet once every two seconds—a comparable dc magnet would require about 150 kW. Furthermore, power supplies for the capacitor banks need only ±1% regulation to reproduce the field during flattop within ±0.005%. (auth)

50492 OPERATION OF COMPLEX ARRANGEMENTS OF POWER SUPPLIES IN THE ZERO GRADIENT SYNCHROTRON EXPERIMENTAL AREA. McGhee, D. G. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 873-4(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The types of power supplies in parallel-series combinations range from 20 kW to 825 kW. They are silicon controlled rectifier or reactor controlled. Each supply has its own isolated power transformer and interfacing is accomplished by interconnecting cable rather than interface transformers. Control is through single reference, either potentiometer or computer generated D to A convertor. The pulse and reaction times of silicon controlled rectifier units, methods of filtering, millisecond reaction interlocking and the economics and efficiencies of operation are discussed. (auth)

50493 IMPROVEMENTS IN TRIM CODE FOR MAGNET DESIGN. Butler, J. W.; Cook, J. M.; Zawadzki, S. A. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 875-7(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The TRIM computer program for the solution of 2-dimensional magnetostatic problems was first developed by Winslow and now exists in several versions. Since the calculation begins with an essentially arbitrary triangulation of field regions, it allows easy and accurate approximation to the irregularly-shaped magnet components usually encountered in practical design problems. The main drawback to extensive use of the code has been its very slow convergence behavior, some problems taking 600 to 2000 iterations, and running times measured in hours even on large computers. By saving certain geometrical quantities which were being recalculated during each iteration, and introducing an "ascending" sequence of mesh refinements ending in the final triangulation, the running times in typical problems were reduced by factors of 6 to 10. Further improvements are expected from the introduction of an improved method of interpolating the vector potential values in the triangular MESH. (auth)

50494 EDGE-COOLED, HIGH-CURRENT SEPTUM MAGNET. Gorka, A. J.; Lari, R. J.; Ratner, L. G. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 878-82(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The resonant extraction system of the Zero Gradient Synchrotron includes a thin septum magnet with a two-turn winding having a total thickness of 0.06 in. The gap height is 2 in. Currents as high as 7000 A (current density of 116,000 A/in.^{2}) produce a field of 3.5 kG across the gap. Simplicity in design has been used extensively in the building of this magnet resulting in an operation life test of one year to date. It is used in a pulsed mode, with a rise time of less than 100 msec and pulses up to 0.8 sec in length. All portions of the design and fabrication are done by taking advantage of commercially available materials and metals and no sophisticated machining practices were used. The computer design, the engineering decisions, the construction practices, and the test data on pertinent parameters are described. (auth)

50495 DESIGNS, PARAMETERS, AND PROBLEMS IN THE ASSOCIATED COOLED EQUIPMENT OF A HIGH PURITY LOW CONDUCTIVITY WATER SYSTEM RATED AT 7,500 GPM AND 25.5 MEGAWATTS. Brunk, W. O.; Harris, C. A.; Robbins, D. B. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 887-9(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The target area cooling water system at SLAC is described, and some recommended solutions to many of the problems encountered in operation and maintenance are presented. Particular attention is given to such items as the selection of the proper strainers and filters; maintaining a high purity low oxygen content water system in the presence of a mixture of materials; the choice of proper insulating hoses and other fittings when voltages up to 600 volts dc are impressed across the hoses; and magnet design problems. A discussion is also presented on the problems associated with a conductive deposit that forms on the inside surface of hoses subject to voltage gradients. (auth)

50496 ITERATIVE PROCEDURE FOR FRINGE FIELD SHAPING WITH LAMINATED POLE CAPS. Johnson, F. E. (Varian Associates, Palo Alto, Calif.); Maraschin, R. A.; Rockhold, C. T.; Reich, J.; Meyer-Boricke, C. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 890-1(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

An iterative and systematic procedure for fringe field shaping of high precision analyzing magnet systems is described. Laminated pole caps allow easy and precise variation of the physical pole boundary. Accurate field mapping and quick data reducing are involved to vary the physical pole boundary systematically. Four steps—each consisting of the variation of the physical pole boundary, field mapping and data analyzing—were necessary to achieve the desired shape of the effective field boundary within 0.2 mm in a 20 cm wide region on a 45 cm wide pole face. This was done on the analyzing magnets of the Juelich double monochromator system which has highly peaked inner pole corners because of large β-angles of more than 50 degrees. This procedure eliminates the model magnet stage and can be done during the manufacturing stage if an automatically controlled field mapping device and quick data handling services are available. (auth)

50497 LAMPF SWITCHYARD MAGNETS. Harvey, A.; Turner, R. D. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 892-3(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The D.C. magnets in the LAMPF accelerator beam switchyard area have the requirements of high quality, low magnetic field strength, and radiation hardness. The first two requirements have led to the use of shimming to provide maximum volume of uniform field in the bending magnets, both transversely and longitudinally. The development of these shims, by computation, and by measurement on a model magnet, is described. Quadrupole shimming is derived from the dipole by conformal transformation, and measured results of harmonic analysis on a prototype 6" bore quadrupole are given. Radiation hardening is provided by winding the coils with mineral-insulated cable, which uses MgO as the insulation. The resulting coils are entirely inorganic. Cooling of the coil conductors is by indirect water-cooling, but the relatively high thermal conductivity of the MgO, with the necessity of conducting heat through the insulation only once, results in low temperature rise in the coils. The cable configuration and manufacturing technique for these coils are described. (auth)

50498 HIGH-FIELD IRON CORE MAGNETS. Danby, G. T.; Jackson, J. W.; Lin, S. T. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 894-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

For small aperture dipoles and quadrupoles, iron core magnets have some very attractive features, even when excited to >40 kG. Iron substantially reduces the current densities and ampere turns in the coils. The simplicity of the coils and the constructional precision of iron boundaries eases the problem of tolerances for very small aperture magnets. Systematic aberrations occur due to

saturation. These must in general be corrected. To test computer calculations vs experiment a highly saturated complex magnetic circuit was deliberately assembled. Studies of aberrations and saturation have been made as a function of field for various geometries. Tolerances on non-systematic aberrations are considered for a variety of iron and air core circuits. It is shown that systematic aberrations in iron core dipoles and quadrupoles can be corrected with a single series circuit, presumably servoed. The corrected field is of very high quality even by conventional magnet standards. (auth)

50499 SOLID STATE DC POLARITY REVERSING SWITCH. Berndt, M. M.; Guracar, C. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 899-900 (Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A dc polarity reversing switch rated at 1000 A and using thyristors (SCR's) instead of mechanical elements is described. The switch was built to allow frequent and rapid reversing of the polarity of the dc magnets in the beam transport system for the SLAC storage ring. A discussion is presented of the design criteria which led to the choice of the circuits used, in particular the current level sensing circuits and the circuit which forces turn-off of conducting thyristors during a reversing cycle. (auth)

50500 MAGNET AC REGULATION AT CEA. Carroll, John A. (Cambridge Electron Accelerator, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 904-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

To maximize the electron or positron current accumulated by multicycle injection in the Cambridge Electron Accelerator it is desirable to keep the lowest value of field during the magnet cycle just below that corresponding to the injection energy. A peaking strip is biased just above the desired minimum field. Pulses are produced as the field passes through the biased value. The elapsed time between these two pulses is proportional to the square root of the ratio of undershoot to amplitude. The time is measured digitally, converted to analog form, and squared by a four-quadrant analog multiplier. An analog offset then yields a servo signal proportional to the error in undershoot during the most recent cycle. Analog calculation based on the field at injection time and the field midway through the cycle determines the bias for the regulator peaking strip. (auth)

50501 ESTIMATIONS OF MAGNETIC FIELD DISTRIBUTIONS IN THREE DIMENSIONS USING A TWO DIMENSIONAL COMPUTER PROGRAM TRIMM. Matin, S. M.; Hay, R. D. (Harvard Univ., Cambridge, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 907-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The TRIMM program for analysis of electromagnet designs is readily applied to cylindrical and infinitely long dipole problems. When the magnet does not conform specifically to the ideal shape, it is necessary to substitute an analytically similar problem to obtain a satisfactory prediction of field. Two cases are presented: one completed H magnet, and a rectangular solenoid, which is now being designed. The Harvard Computing Center 360/65 was used in this work. (auth)

50502 BEAM CURRENT AND POSITION MONITORS AT THE NBS LINAC. Menke, J. L. (National Bureau of Standards, Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 909(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

During the development of a new beam current and position display system, the quality of the signals and the convenience of the display have been of most importance. The quality of the signals from the ferrite-loaded toroids and solenoids has been improved by careful noise shielding from modulators and beam return currents, and by steps taken against beam-induced microwave signals. The beam display is a set of edgewise meters showing beam current and position along the linac. Logarithmic scales for current and variable gain amplifiers for the position channels allow convenient use of the system. (auth)

50503 BEAM MICROSTRUCTURE: DOES IT AFFECT FERRITE-LOADED CURRENT MONITORS. Menke, J. L.; Pruitt, J. S. (National Bureau of Standards, Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 910-12 (Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Questions have been raised as to whether the current calibration of a ferrite-loaded toroid beam monitor using a pulser is also valid for a linac beam with 1300 MHz microstructure. Three experiments are reported; (1) a comparison of a ferrite toroid and a precision Faraday cup by a nulling experiment, (2) a comparison of a ferrite toroid and a Faraday cup using a special calibration technique, and (3) a direct comparison of a ferrite-loaded and an air-core toroid. The evidence is that the error, if present, is under 1 percent. Systematic errors due to beam-induced microwaves are also discussed. (auth)

50504 ISR BEAM POSITION MONITORING SYSTEM. Borer, J.; de Jonge, M. J. (European Organisation for Nuclear Research, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 913-15(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The beam position monitoring system (BPMS) built for the Intersecting Storage Rings (ISR) of CERN, as used during the present running-in period, is described. Beam observation is based on the direct viewing of beam signals which permit the study of beam dynamics from beam intensity, position and longitudinal structure. The beam position is calculated from the video signals, presently recorded on photographs. The video (wide band) part of the BPMS consists of the beam monitors (P.U.), head-amplifiers, end of cable amplifier, cable, selection-switch system and finally a dual beam scope. It allows the observation of the beam induced signal on vertical or radial pairs of electrodes on each of the 53 P.U. in both rings. The bandwidth of the system is 30 kHz to 50 MHz in the main control room and 2 kHz to 110 MHz in auxiliary buildings. A description of the performance of the video signal observation system is given. (auth)

50505 CURRENT MODE READOUT OF SECONDARY EMISSION CHAMBERS. Greeley, F.; Bogaty, J.; Faber, M. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 916-17(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The usual technique for readout of charge in a secondary emission chamber is to allow the chamber capacitance to integrate the charge and read the resulting voltage with an electrometer located very close to the chamber. The chamber must then be discharged to be ready for the next beam pulse. An alternate technique that uses an operational amplifier as a current-to-voltage converter followed by an operational amplifier integrator is described. An auxiliary discharge device is no longer needed since the electronics used inherently leave the chamber in a discharged state. A second advantage is that the electronics may be located as far as several thousand feet distant from the chamber. Also a method of achieving a dynamic range in the current-to-voltage converter that allows a readout of both very fast and very slow beam spills is described. This system is used at the ZGS. (auth)

50506 ZERO GRADIENT SYNCHROTRON CLOSED ORBIT POSITION MONITORING SYSTEM. Potts, C. W.; Brumwell, F. R. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 918-19(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Four quadrant induction electrodes are being installed in each of the eight ZGS straight sections. Due to the presence of other equipment, these electrodes can only be 10 inches long in the direction of beam travel. Five pieces of information are transmitted from each electrode to give detailed data on the beam orbits. Four of these consist of varying dc signals representing the beam envelope on the quadrants. These signals are electronically processed to simultaneously give radial position and vertical position. The fifth signal may be either a fast radial, fast vertical, or fast Q. This is provided by an rf amplifier located near the electrode. In many cases, these fast signals are used in active systems. The electronics which are used in signal processing and the generation of control room displays are discussed. Construction details are provided. (auth)

50507 FAST BEAM QUALITY MEASURING DEVICE. van Kampen, W. A.; Liedorp, J. (Delft Univ. of Tech., Netherlands). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 923-5(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A device has been designed and built to obtain the four dimensional emittance of a particle beam. Two rotating discs, one meter apart, are placed in the beam. Both discs have hole patterns, and scan the beam using the Nipkov principle. The selected part of the beam is measured with a Faraday cup. The current obtained from the cup is sampled in time. Every sample yields the beam content of a volume element in phase space the coordinates of which are

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determined by the positions of the discs. A PDP-8/L computer is used to control the experiment, to monitor the disc positions, and to store the measurement data on a 32K word disc file. The number of samples in one measurement cycle depends on the hole patterns in the discs. At present a cycle takes about 20 seconds and contains 10,000 measurements of 1 ms each. Faraday cup currents of 10^{-9}A and up are measured with 1% accuracy. (auth)

50508 HIGH-RESOLUTION BEAM INTENSITY PROFILE MONITOR. Walz, D. R.; Seppi, E. J. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 926-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

An intercepting beam intensity profile and position monitor was developed. It has excellent spacial resolution as well as signal efficiency and for certain applications it is superior to such widely used instruments as SEM's, Cherenkov light, and screen profile monitors. The instrument utilizes the electromagnetic cascade shower emission effect. Multiplicity in a high-Z material at SLAC energies is substantial, and it is not too difficult to obtain net charge leakage signals which are comparable in magnitude to the intercepted beam current. The existing monitor consists of an array of closely spaced tungsten ribbons (0.005 inch apart, 0.005 inch thick, 2 r.l. depth in beam direction). At an incident beam energy of 10 GeV and a pulse length of 1.5 μsec the observed current signals are approximately 5 times the intercepted beam current. The principle features of the monitor are discussed and illustrated, including performance data for various incident beam energies, currents, and ribbon dimensions. The basic instrument has a wide range of applications; three are discussed in detail: (1) a spectrum analyzer; (2) a ring inflection monitor for the SLAC storage ring project which involves monitoring of low-intensity electron-positron beams; and (3) an accelerator beam phase space measurer located in the beam switchyard tune-up area. (auth)

50509 BEAM CURRENT MONITOR FOR THE OAK RIDGE ELECTRON LINEAR ACCELERATOR. Millard, J. K.; Lewis, T. A.; Allin, G. W. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 929-31(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A toroidal induction monitor was designed for the Oak Ridge Electron Linear Accelerator (ORELA) to provide a visual display of beam current pulses having peak amplitudes up to 15 amp with widths ranging from 3 to 200 nsec. To achieve rise times of about 1 nsec, the monitor was designed to utilize the influence of the electric field of the electron bunch to improve the response time of the magnetically induced output pulse. The final monitor design consists of a Ferroxcube 400T750, ferrite toroidal core of 1.25 in. ID wound with ten symmetrical turns of AWG 26 Formvar copper wire. The toroid is mounted at the end of the last acceleration tube in an assembly which includes a 0.9-in. ID collimator preceding the toroid. For simplicity of mechanical design, the toroid is operated at the vacuum level of the acceleration tube. (auth)

50510 AUTOMATIC GAIN-CONTROLLED AMPLIFIER FOR BEAM PROFILE MONITORS. Rogers, P. C.; Potter, D.; Radeka, V. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 932-4(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

An amplifier for beam profile monitors of the moving-wire type has been developed in which photo-controlled resistors are used to vary the gain so that the output peak amplitude remains constant. The peak output signal is independent of the intercepted beam current over the range 4×10^{-3} to 4×10^{-10} amps. The noise referred to the input is less than 10^{-11} amps rms. The rise time at maximum gain is 20 μsec. The feedback control loop maintains approximately constant gain during a single sweep period yet can change the gain over several decades in one second. The control loop operation is independent of the polarity of ions impinging upon the wire. At any given gain the amplifier response is linear. With this amplifier in operation it is not necessary to manually change gains as the beam intensity varies over the range of beam currents commonly encountered with particle accelerators. (auth)

50511 BEAM-PROFILE MONITORING AND ANALYSIS BY TELEVISION. Parker, J. R.; Allison, P. W.; Mueller, D. W.; Stevens, R. R. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 935-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The usefulness of the pepper-pot emittance device for performing quantitative beam diagnostics has been extended to real time by employing a video analyzer to analyze the pepper-pot scene as viewed by a television system. The video analyzer produces a display of the intensity as a function of position and directly recognizable angular information. A television monitor displaying this information is located near the beam controls. The pepper-pot scenes, complete with beam data, can be stored on video tape for later analysis. Means are also provided for generating a three-dimensional plot of the pepper-pot scene on an x-y plotter. Time dependence of the beam emittance is obtained by placing an image intensifier ahead of the television camera. (auth)

50512 MEASUREMENT OF CROSS SECTION OF A HIGH-ENERGY ELECTRON BEAM BY MEANS OF THE X-RAY PORTION OF THE SYNCHROTRON RADIATION. Hofmann, A.; Robinson, K. W. (Cambridge Electron Accelerator, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 937-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Synchrotron light is used routinely in measuring the cross section of a high-energy, orbiting, electron beam. The resolution of the height measurement is limited by the small vertical opening angle of this light. Because the angle decreases as a fractional power of decreasing wavelength, it is advantageous to use a shorter wavelength portion of the synchrotron radiation, i.e., the x-ray portion. Accurate measurement of beam height is especially important to the CEA colliding beam program. A pinhole was installed in one of the tangential beam runs and the x-radiation image of the beam cross-section was recorded with a Polaroid x-ray cassette. A resolution of about 0.1 mm in beam height was obtained. The height data obtained for stored beams at several energies were in agreement with expectations. (auth)

50513 FAST BEAM MONITOR USING SYNCHROTRON LIGHT. Sabersky, Andrew P. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 939-40(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A new type of fast beam-bunch monitor with a 0.1 ns risetime, useful for studying relativistic electron beams, is described. The device is a coaxial vacuum photodiode looking directly at the whole spectrum of synchrotron light from relativistic electrons in a bending magnet. (auth)

50514 BEAM-EMITTANCE MEASUREMENTS ON THE NAL 200-MeV LINAC. Gray, Edward R. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 941-2(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The need for a fast (minutes) emittance-measuring device was recognized early in the development of the NAL linac. Systems using destructive slit devices and thin-wire scanners have been reported. Improvements in the anlysis of wire profile data and measurements of the 200-MeV linac beam emittance are reported. (auth)

50515 CYBERNETIC ACCELERATORS. Mints, Alexander L. (Academy of Sciences, Moscow). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 943-7(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The history, principles of design, and some features of cybernetic proton accelerators developed and investigated in the USSR to obtain super-high energy particles up to 1000 GeV are described. A description of a 1 GeV scale model of the large machine and the results of investigations carried out on it are given. It is shown that the use of superconducting magnet units permits to obtain energies as high as 4000 GeV with an orbit of about 17 km. (auth)

50516 STATUS OF THE 500 GeV ACCELERATOR. Malamud, Ernest (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 948-52(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Topics include the beam injection system; civil engineering; main ring magnets; vacuum system; power supplies; low conductivity water system; alignment; rf system; installation progress; and injection control system, auxiliary magnets, and beam diagnostics. (W.H.K.)

50517 ARGONNE ZERO GRADIENT SYNCHROTRON (ZGS) BOOSTER. Martin, R. L. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 953-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

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The former Cornell 2.2-GeV electron synchrotron operating at 30 Hz will be used as a rapid-cycling booster for injecting protons at 200 MeV into the ZGS to increase the space charge limited intensity of the ZGS. Negative hydrogen ions of 50 MeV will be injected into the booster with the electrons stripped at injection for acceleration of protons. The reasons for using this type of injection along with the history and status of the program are discussed. (auth)

50518 OPERATION AND IMPROVEMENT OF THE CORNELL 10 GeV ELECTRON SYNCHROTRON. Tigner, Maury (Cornell Univ., Ithaca, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 957-9(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Performance figures for the past year are presented. Several improvements in equipment and technique that have had a significant impact on the physics program are discussed. Among these are the installation of two external electron beam systems, chopping of the linac beam, adjustable beam bump shaping, improved shielding, remote controlled targets, new methods of beam sharing and new modulators for the RF system. A brief presentation of future plans is made. (auth)

50519 SUBHARMONIC PREBUNCHING. Gallagher, W. J. (Applied Radiation Corp., Walnut Creek, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 960-1(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Several applications exist where the normal rf structure of the beam from an electron linac is undesirable. For example, linacs as synchrotron injectors are generally operated on the sixth (or seventh) harmonic; since only one (or possibly two) rf cycles are captured into the synchrotron, elimination of the excess beam is desirable. Additionally, in some counting schemes it is possible to use single pulses (or packets) if the interpulse time is sufficiently long, which may be achieved by means of bunch suppression. Further, it is also possible to produce single bunches (picosecond pulses) in cases where the gun pulses are less than one cycle of the subharmonic frequency. The results of a study of bunching by velocity modulation, employing two single gap cavities, the beam passing first through a cavity supporting the subharmonic gap voltage and, after an appropriate drift space, through a gap voltage at the basic frequency followed by a second drift space are presented. A disc model of the beam is used to incorporate the effects of space charge; the kinematics are relativistic. (auth)

50520 OPERATIONAL EXPERIENCE WITH A PROTOTYPE FAST KICKER MODULATOR. Fruitman, M. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 962-3(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The design and operating experience of a prototype "Fast Kicker" modulator which was intended for use as one of four modules in the fast extraction system of the AGS are described. Changes in the mode of operation of the AGS have negated the proposed use of this Fast Kicker, but its operation with pulse outputs of 106 kV and 7500 amperes with a rise time of 200 nsec warrants its description. Moreover, the considerable life testing of the modulator under conditions similar to typical use has yielded valuable information on the suitability of various components for such a circuit. The circuit used and tested was a "Blumlein" configuration, which has the characteristic of yielding the same voltage output as that to which the pulse forming network is charged. This allows the use of a higher impedance load within the voltage limitation of the switch and offers the benefit of shorter rise and fall times. Specific component success, and failures, are described. (auth)

50521 EXTERNAL BEAM FROM THE CORNELL 10 GeV SYNCHROTRON. DeWire, J.; Edward, H.; Littauer, R.; Rouse, G.; Sundelin, R. (Cornell Univ., Ithaca, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 964-5(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The electron beam at the Cornell 10 GeV Synchrotron has been extracted using a quadrupole and octupole magnet to drive the beam into a half-integral stop band. Extraction is then effected by three septum magnets. An achromatic transport system delivers the external electron beam into either of two experimental areas producing a focused spot at the experimental target of the order of 1 millimeter square with a divergence of ±0.3 milliradians. At 10 GeV an electron beam with an intensity of 2×10^{10} electrons per pulse and a duty factor of 10% has been obtained. The extraction efficiency is 85% at 5 GeV and falls to 70% at 10 GeV. By using only the septa, up to 1% of the beam can be extracted without interfering with an internally made photon beam, thus allowing simultaneous use of external electron and photon beams. (auth)

50522 EFFECTS OF SEXTUPOLE FIELDS ON SLOW EXTRACTION IN A HIGH FIELD SUPERCONDUCTING ACCELERATOR. Month, M.; Chasman, R. W.; Parzen, G. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 966-7(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Resonant slow extraction from the cold magnet synchrotron (CMS) as proposed at BNL is complicated by the presence of large sextupole components in the lattice bending magnets. The dominant consequence of the systematic sextupole components in these magnets (due to magnet saturation at high fields) is a zeroth harmonic in the sextupole distribution around the accelerator. Further, a mechanical limit on the positioning of the coils within the magnet aperture implies the existence of bending magnet sextupole components which can be thought of as varying randomly from magnet to magnet. This introduces an azimuthal sextupole distribution containing all harmonics—in particular, the resonant harmonic. The effects of both these types of errors on slow extraction are discussed. Their partial elimination with the use of correction sextupole and octupole magnets is suggested and tolerances on both the magnetic field error (sextupole component) and coil positioning are estimated. (auth)

50523 USE OF A DEBUNCHER IN THE INJECTION PATH OF AN ELECTRON SYNCHROTRON. Crowley-Milling, M. C.; Saxon, G. (Darsbury Nuclear Physics Lab., Warrington, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 968-9(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The insertion of a beam transport system involving 4 bending magnets in the flight path from the 43 MeV linear accelerator to the 5 GeV electron synchrotron, NINA, at Daresbury, led to the design and installation of a system for reducing the energy spread in the injected beam. Debunching is obtained through the difference in path length for electrons of different energy in the beam transport system. An r.f. cavity, consisting of a short length of iris-loaded waveguide, suitably powered and phased, then reduces the energy deviations to a negligible value. This is believed to be the first use of a debuncher in connection with an electron synchrotron. The installation and its effect on system performance are described. (auth)

50524 APERTURE UTILIZATION IN THE AGS. Herrera, J. C.; Raka, E. C.; Gill, E. G. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 970-2(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

In order to maximize the accelerated beam intensity in the Brookhaven AGS, it is important that the available horizontal and vertical admittance be filled. It is for this reason that multiturn injection is used. The efficiency of utilizing the available apertures is limited by the emittance and energy spread of the linac, the equilibrium orbit distortions, the resonance losses due to gradient errors, etc. By flipping targets into the edge of the beam and observing the accompanying beam loss, the size of the beam in the AGS was measured at injection time and during the acceleration cycle under various operating conditions. These results are presented and used to estimate the efficiency of utilization of the available aperture. (auth)

50525 MEASUREMENT OF THE CERN SLOW EJECTED BEAM TIME STRUCTURE. Bloess, D. (CERN, Geneva); Dekkers, D.; Shering, G.; Sandels, E. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 973-5(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The slow ejected beam time structure is measured to quantify its effect on physics experiments and to obtain information on the synchrotron behavior. An analytic basis for the measurements, the various equipment used, and some results are discussed. A specially designed time interval measuring device, having no dead time, is used to analyze telescope pulse trains to give a measurement of the overall radiofrequency structure every synchrotron cycle. The pulse trains are also analyzed using delayed coincidences. A flux monitoring scintillator is used to provide an analog signal proportional to the beam flux, permitting the time structure up to 50 MHz to be viewed directly. The low frequency structure is measured by computer sampling an analog burst signal at 10 kHz. The computer then calculates the effective spill time, the ripple duty factor, and the frequency spectrum of the ripple. (auth)

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50526 KICKING PROTONS, FAST AND CHEAP. Bueckner, A. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 976-7(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The kicker magnets for injection into and ejection from the CERN PS Booster produce fields with a very fast rising or falling edge. By making only the required slope fast, special circuits and devices resulting in important economies were developed, such as saturating pulse-steepening lines, pulse-forming circuits with equal storage line and magnet voltages, and energy consuming self-triggering spark-gap "tail biters" for a wide voltage range, making it possible to shorten the classical Blümlein line by a factor of two. The following special items, which are also of interest for other applications, are described more in detail: (i) circuit for preventing HV thyratron self-triggering in case of a fast-rising anode voltage with rise times as fast as 50 ns, (ii) a self-triggering "tail biter" series spark-gap for a wide voltage range, (iii) drift-stabilizing feedback circuit with digital memory and 1 ns resolution. (auth)

50527 INITIAL OPERATION OF THE NAL BOOSTER. Billinge, R.; Kerns, Q. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 978(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The booster synchrotron is a major component of the injector system for the NAL 500-GeV synchrotron. It has been designed solely to perform its injector function of providing close to 10^{14} protons per second at 8 GeV during the filling time of the main accelerator. The commissioning and early accelerator studies of the booster are described with emphasis on its role as an injector synchrotron. (auth)

50528 INJECTION INTO THE 8 GeV BOOSTER SYNCHROTRON. Billinge, R.; Hubbard, E. L.; Juhala, R.; Oram, R. W. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 979-80(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The beam intensity in the 8-GeV booster synchrotron must be 4.2×10^{12} protons per pulse in order to reach the design intensity of 5×10^{13} protons per pulse in the NAL 500-GeV main synchrotron. To reach this intensity, stacking four turns of the 200-MeV linac beam in the radial betatron space of the booster are planned. The incoming beam is bent 8.3° to make it almost parallel to the booster orbit by a 3-kG dc magnet with an 0.2-in. thick septum. The final 0.7° bend is done by an electrostatic inflector with an 0.002-in. wire septum located 1.125 in. outward from the closed orbit. During injection, the closed orbit is deflected outward by a set of four magnets in the 6-meter long straight section used for injection. This orbit displacement decays during injection to achieve the radial stacking. The beam from the 200-MHz linac is allowed to debunch longitudinally and is rebunched and captured adiabatically by the 30-MHz rf acceleration system in the booster. Beam studies with this injection system are described. (auth)

50529 BEAM ABORT SYSTEM FOR THE NAL 500 BeV SYNCHROTRON. MacLachlan, J. A. Jr. (National Accelerator Lab., Batavia, Ill.); Borak, T. A.; Teng, L. C.; Shoemaker, F. C. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 981-3(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

An internal beam dump is designed for the NAL main ring to dispose of circulating beam at any time during the acceleration cycle. An abort at full beam power is an emergency procedure, but activation of the system at the end of every cycle purges unextracted protons and provides a continuous check on system operability. The system consists of a full aperture vertical orbit bump in a 50 m drift space which carries the beam onto a 6 m aluminum and steel dump. Four 12.8 kG vertical bending magnets excited from individual 18 kJ capacitor banks provide a full aperture kick in 84 μs. Monte Carlo calculations show that primary stopping efficiency of about 99.8% can be expected, but that local heating problems will require a cautious approach to full beam power dumping. (auth)

50530 DESIGN OF THE 500 GeV SLOW EXTRACTED BEAM AND PROTON BEAM LINES. Rode, C. H.; Andrews, R. A.; Maschke, A. W.; Mobley, R. M. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 984-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The layout of the extraction system and proton beam transport to the experimental areas is shown. Experimental results of the electrostatic septum and Lambertson septum testing are discussed. Also presented are the tunnel complex and optical system for the proton beam lines. (auth)

50531 NAL BOOSTER-TO-MAIN RING BEAM TRANSFER SYSTEM. Maschke, A. W.; Oleksiuk, L. W. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 989-90(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The process of transferring the 8 GeV proton beam from the rapid cycling booster synchrotron to the main accelerator at NAL is described in terms of overall system features and optical parameters. Recent tests of the transfer system, using a 1 GeV booster beam, have yielded successful beam extraction from the booster synchrotron of close to 100% efficiency, at low beam intensities (~1 mA). Injection into the main accelerator has been accomplished with indications of good transverse matching and good overall control system stability. (auth)

50532 PULSED SEPTUM MAGNET AND POWER SUPPLY FOR THE 8 GeV BEAM TRANSFER LINE AT THE NATIONAL ACCELERATOR LABORATORY. Visser, A. T.; Nissen, R. F. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 991-3(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The construction of the pulsed septum magnets and their power supply used in the 8 GeV beam transfer line between the NAL booster and main ring is briefly described. The solid state power supply provides 20,000 A pulses at about 1500 V and a PRR of 15 per second. (auth)

50533 ALIGNMENT TECHNIQUES FOR THE NAL MAIN ACCELERATOR. Schivell, J.; Schmidt, C. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 994-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The alignment procedure for the NAL main accelerator makes use of the fact that short-wavelength disturbances in the magnet positions are much more important than those of long wavelength. Therefore, there are relatively few survey monuments, and their accuracy does not need to approach the ultimate accuracy of the magnet placement. In this separated-function lattice, the quadrupoles are aligned with respect to their near neighbors to better than ±0.010 in. Radial and vertical offsets with respect to near quadrupoles are measured rapidly with an optical-tooling laser and a detector system specially designed to minimize the effects of beam-alignment fluctuations. The results are Fourier analyzed, and the lowest harmonics dropped before recombining into position adjustments. The alignment is closed for $\frac{1}{6}$ of the ring at a time, making use of 6 target points. Information from the beam-position monitors will be used to make final adjustments to quadrupole positions. (auth)

50534 SYSTEM FOR INJECTION STUDY OF THE NAL MAIN ACCELERATOR. Feng, H.; Malamud, E.; Mori, S.; Schivell, J.; Yamada, R. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 997-9(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Instruments for injection and preliminary studies of a 1 GeV proton beam injected into the main accelerator ring of the NAL 500 GeV Synchrotron are described. After six hours of tuning a relatively unattenuated beam was observed at a point some 1200 feet into the first superperiod (Superperiod A) of the accelerator. Further studies were not possible at this time because of fluctuation in beam quality. (auth)

50535 MEASUREMENT OF THE TITANIUM VACUUM CHAMBER EDDY CURRENT FIELDS AND POLE FACE WINDING CORRECTIONS FOR THE ZERO GRADIENT SYNCHROTRON (ZGS). Crosbie, E.; Khoe, T.; Berrill, E.; Hardek, T.; George, R. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1000-1(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The titanium vacuum chambers which will be installed in the ZGS are equipped with pole face windings for correction of the eddy current fields. A prototype of the chamber and correction windings has been installed in a spare magnet block test fixture for measurement of the eddy current fields as a function of radial position and time. The ten difference signals from 20 test coils are read into an SEL-810 computer. The computer displays the

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measured gradient on a scope, either as a function of radial position at a selected time during the magnet pulse or as a function of time at a selected position. Thus, the result of applying compensating pulses to the pole face windings can be shown directly. (auth)

50536 RESONANT EXTRACTION AT THE ZERO GRADIENT SYNCHROTRON (ZGS). Ratner, L. G.; Crosbie, E. A.; Khoe, T. K.; Marmer, G. J. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1002-3 (Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A resonant extraction scheme utilizing the $\nu_x = 1$ integral resonance has been successfully used at the ZGS. The system consists of a full sextupole magnet used to drive the unstable protons radially inward toward a 1.5-mm septum magnet located three octants (≈0.3 betatron wavelengths) downstream. The thin septum magnet jumps the protons radially inward across the thick septum of the regular extraction magnet two octants further downstream. This magnet drives the beam outward into the extraction chain one octant later. Due to the scalloping of ZGS orbits at high energy, it is not necessary to plunge any of these magnets. A description of the system and operational results is presented. (auth)

50537 USE OF QUADRUPOLES IN RESONANT EJECTION IN VIEW OF THE MATCHING OF THE BEAM EMITTANCE TO THE EXTRACTION CHANNEL. Hilaire, A. (CEA, Saclay, France); Laisne, A. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1004-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

It will be shown that, on a separated function machine with a $\pi/2$ betatron phase advance per cell, (a) in the case of an integer resonant extraction, the use of two quadrupoles $\pi/2$ apart allows the diverging separatrix to rotate in the entrance extraction channel phase plane, and (b) in the case of a $\frac{1}{2}$ resonance, two quadrupoles $K\pi$ apart provide the same matching. (auth)

50538 AGS LATTICE CORRECTIONS AND TUNING USING BACKLEG WINDINGS. Danby, G. T.; Jackson, J. W.; Raka, E. C. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1007-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The excitation of a novel backleg winding system has significantly contributed to increasing the intensity of the AGS. The benefits of the improved magnetic lattice properties at fields in the vicinity of injection were demonstrated, both for future operations and for quantitative study of high intensity phenomena. A record intensity of 3.2×10^{12} protons per pulse was attained when some portions of these windings were activated. The ideas used and the simple approach to orbit analysis are described. (W.H.K.)

50539 FAST EXTRACTION OF DEBUNCHED AGS BEAM. Blumberg, L. N.; Cottingham, J. G.; Glenn, J. W.; (and others) (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1009-14(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A new system for fast extraction of the AGS beam is described in which the beam is moved rapidly across a hyper thin septum (HTS) and deflected into the aperture of a thin-septum ejection magnet (EM). The effects of momentum spread on the clearance obtained at the ejector septum are calculated. Orbit deformations from $\lambda/2$ backleg winding bumps centered at the septum and ejector azimuths are calculated and the effects of these perturbations on orbits near the $\nu_H = 9$ resonance are discussed. Loss calculations for an electrostatic HTS indicate that proton losses will be 0.1% per turn for a .002 in. diam. tungsten wire array or 0.8% per turn for a .002 in. copper foil. The ferrite beam kickers required for the fast deformation at the HTS are described. Component parameters for fractional extraction are: C15 and E15 beam kickers = .75 mrad, E10 HTS = 1.2 mrad, H10 EM = 22 mrad, and I10 EM = 21 mrad. Results of initial tests with a 2.25 m electrostatic septum of .1 mm diam. tungsten wires at 2 mm spacing are discussed. (auth)

50540 STUDY OF THE ONE-THIRD INTEGER RESONANCE EXTRACTION FOR THE 200 GeV ACCELERATOR. Ohnuma, Shoroku (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1015-17 (Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Results of a detailed numerical study on the slow extraction of 200 to 400 GeV beams from the NAL accelerator are presented. Topics discussed are: position and strength of sextupoles, effects of octupole components in the ring magnets, vertical motion with the resonance $2\nu_y + \nu_x = 61$, and effects of ripples in the quadrupole current. With two sextupoles of strength 400 to 800 kG/m, the turn separation is ~1 cm when the septum radial position is 3 cm. The direction of the beam at the septum can be varied with correction octupoles. A possible advantage of introducing a local bump in the closed orbit near the septum is also discussed. (auth)

50541 CHANGING THE HARMONIC NUMBER IN A SYNCHROTRON DURING ACCELERATION. van Kampen, W. A.; Schreuder, H. W. (Delft Univ. of Tech., Netherlands). IEEE (Inst. Elec. Electron. Eng.)., Trans. Nucl. Sci.; NS-18: No. 3, 1018-19(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

In the Delft 1 GeV proton synchrotron the harmonic number is changed during acceleration. It is discussed how this technique for reducing the frequency sweep of the rf system may be used to utilize to the full extent the magnetic guide field of a proton synchrotron when accelerating heavy ions. (auth)

50542 CONDUCTIVE COATING FOR CERAMIC BEAM TUBES. Tilles, E. B.; McCarthy, J. D.; Nissen, R. F. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1020-1(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The conductive coating and process was developed in conjunction with the pulsed magnets used in booster extraction and main ring injection at NAL. A coating of indium oxide is deposited the full length of the inner wall of the ceramic tube. Due to the various frequency components in the magnetic fields of the pulsed magnets, coating thickness and resistance are closely controlled. Tube preparation and deposition techniques used are detailed, as are test data and results. (auth)

50543 HARDWARE FOR A FULL APERTURE KICKER SYSTEM FOR THE CPS. Fiander, D. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1022-3(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

It is expected that after completion of the CPS improvement program the existing small aperture plunging kicker magnets may be unable to efficiently eject a high intensity beam because of aperture and rise time limitations. A full aperture kicker system which is being developed to permit full exploitation of high intensity fast ejected beams from early 1973 onwards is described. The design of the magnets and pulse generators is presented, together with their predicted performance. The measured performance of prototypes and the results of extensive life testing are given. (auth)

50544 ACCELERATION AND EJECTION OF DEUTERONS OF THE DUBNA SYNCHROPHASOTRON. Baldin, A. M.; Beznogikh, Yu. D.; Issinskii, I. B.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1024-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Some units of the Dubna Synchrophasotron have been readjusted for accelerating deuterons up to 10 GeV. The linac accelerating structure and rf supply of the Synchrophasotron have been modified. Physics experiments with the deuteron beam have been started. Machine readjustments and deuteron acceleration are described. (auth)

50545 HIGH INTENSITY PHENOMENA OBSERVED IN THE CPS. Baconnier, Y.; Gareyte, J.; Lefevre, P. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1027-31(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A review of high intensity phenomena observed in the CPS is presented. At injection an attempt is made to describe the combined effect of space charge and resonances, which result in a loss of 70% of the injected beam intensity and a reduction by a factor of 3 of the central core brilliance. Results of measurements on the effect of a localized bad vacuum are given. The situation at transition is briefly described. Seven different instabilities observed in the CPS in longitudinal or transverse phase plane are analyzed. The compensation techniques are described in all cases. Whenever possible an attempt has been made to give some qualitative explanation of the mechanism. (auth)

50546 HIGH INTENSITY BEAM INSTABILITIES IN THE BROOKHAVEN AGS. Barton, M. Q.; Raka, E. C. (Brookhaven

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National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1032-4(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Transverse resistive wall instabilities and longitudinal reactive wall instabilities have both been observed in the Brookhaven AGS. Recently an instability has been observed characterized by individual coherent phase oscillations of the twelve beam bunches. This instability is believed to be caused by high frequency resonance modes in the rf cavities introduced by recent modifications. A simple analysis shows that voltages induced in these parasitic resonances by the beam can couple the phase oscillations of the individual bunches. A normal mode analysis of the system predicts unstable normal modes with properties similar to the observations. Modifications to the rf cavities to suppress these undesirable effects have been devised. (auth)

50547 BEAM INSTABILITIES OBSERVED AT THE CEA. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1035-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Single beam instabilities have been observed at the Cambridge Electron Accelerator during accumulation and storage of electron and positron beams. In the filling mode, the instability appears at about 3 mA peak current. It develops structure in the beam sausage, makes the beam horizontally larger with increasing currents, shortens the decay time, and limits the maximum accumulated peak current to 40 mA for electrons and 10 mA for positrons. The instability involves an interaction over several bunches. Coherent horizontal betatron and phase oscillations have been observed in connection with the instability. The threshold could be increased with a high frequency quadrupole powered at a harmonic of the circumference frequency. It gives different bunches different ν values, which reduces the bunch-bunch interaction. The instability associated with the phase oscillation was reduced with a cavity oscillating at a different harmonic number from the RF. Neighboring bunches now see different RF-voltage gradients and have different synchrotron oscillation frequencies. Peak currents of 70 mA for electrons and 25 for positrons were achieved. During the storage mode, vertical and horizontal single bunch instabilities have been observed. Their threshold can be increased with octupole fields. The beam-beam interaction during accumulation and without separation has been investigated. The threshold seems to be independent of the number of bunches (or the ν-value shift if there were more than 25 bunches in each beam). (auth)

50548 PROPAGATION CHARACTERISTICS OF FINITE LENGTHS OF PERIODIC STRUCTURES. Gallagher, W. J. (Applied Radiation Corp., Walnut Creek, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1045-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

In linearized (matrix) models of periodic structures the propagation characteristics or unforced solutions are the eigenvectors of the transfer matrix for a single period of the structure. This solution is, however, only applicable to an infinite length of the structure. If n periodic lengths (or sections) are cascaded the overall transfer matrix is the n-th power of the matrix for one periodic length, which can be reduced by means of the Cayley–Hamilton theorem. Examination of this reduced matrix reveals that the propagation characteristics of a finite length of a periodic structure can be expressed in terms of rationalized Tschebyscheff polynomials. The two analyses are shown to converge as $n \to \infty$. An example is presented to illustrate the differences between a finite length and an infinite line. (auth)

50549 SHAKING OF PARTICLE BEAMS TO REMOVE NEUTRALIZING IONS. Peterson, M. M. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1049-51(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Positive ions produced through ionization of the residual gas by the electron beam in an accelerator or storage ring can be trapped in the potential well of the beam and produce focusing forces on the beam that can shift the betatron frequency onto a resonance or stimulate other beam-dynamics effects. At low beam intensity the ions can be removed by means of the electric field imposed by clearing electrodes; however, at high intensity clearing electrodes can become ineffective when the local field of the beam is greater than that imposed by the electrodes or even harmful because of electromagnetic interaction between the beam and the electrode system. The ions can be removed also by letting them coast to the walls in the interval during an empty gap in the beam, but the length of the necessary gap in many cases is impractical. A new method, called "beam shaking", is proposed for removing the neutralizing ions by inducing increasingly larger amplitudes of ion oscillation about the beam until they are driven to the walls. (auth)

50550 SYNCHROTRON–BETATRON OSCILLATION COUPLING IN NINA. Crowley-Milling, M. C.; Rabinowitz, I. I. (Darsbury Nuclear Physics Lab., Warrington, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1052-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The maximum current that can be accelerated in the electron synchrotron NINA, as with other electron synchrotrons, is appreciably less than would be expected from theoretical considerations. Recently work has been concentrated in trying to discover the mechanisms responsible for the beam loss, and in re-examining the theory, to see if any significant factors have been omitted. As far as the latter is concerned, it has become clear that, particularly for NINA, the betatron oscillations caused as a result of the relatively large energy increment gained at each cavity cause an appreciable loss of available aperture. In addition, there are resonances which occur at particular values of the synchrotron oscillation frequency, and these can lead to loss of beam current. Since there is a variation of synchrotron frequency with amplitude, an unstable situation can occur, leading to the loss of all electrons which exceed a certain amplitude of oscillation. Measurements made on NINA have demonstrated the predicted resonances, and it is shown that some improvement should be obtained by altering the spacing between the cavities. (auth)

50551 BEAM BUNCH LENGTH MATCHING AT TRANSITION CROSSING WITH SPACE-CHARGE FORCES. Lee, W. W.; Teng, L. C. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1057-61 (Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The compensation of the mismatch of beam bunch length due to longitudinal space-charge forces in crossing the transition energy is studied. The rms beam bunch length (envelope) equation for small phase oscillation is solved numerically. The results indicate that perfect matching of bunch length for high intensity beams is possible by using the γ_t-jump or ϕ_s-jump schemes. (auth)

50552 BEAM DEBUNCHING. Ruggiero, A. G. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1062-5(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The beam debunching problem is approached directly by writing down the rms bunch length equation in the presence of space charge forces. Besides the usual reactive beam-wall coupling field, the wake fields caused by the resistivity of the wall material and the RF accelerating cavities are also taken into account. The rms length equation is integrated for the special case of the NAL main ring with special attention to detuning of the cavities. The result is a debunching criterion which can be easily fulfilled for ordinary operating conditions. (auth)

50553 EFFECT OF SPACE CHARGE IN BEAM TRANSPORT LINES. Sacherer, F. J.; Sherwood, T. R. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1066-7(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Two computer programs have been developed that follow the evolution of particle distributions in six dimensions. The first includes only the linear part of the space-charge force. It has been incorporated into the program TRANSPORT so that any linear optics problem that can be solved without space charge can now be solved with space charge. The second program, which includes non-linear effects, follows the motion of 650 superparticles. For the new 50 MeV transfer line at CERN, in which space-charge effects are important, the results of the two programs are in good agreement. (auth)

50554 STUDIES OF SPACE CHARGE NEUTRALISATION IN INTENSE 500 keV PROTON BEAMS. Evans, L. R.; Warner, D. J. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1068-72(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Some aspects of the transport of intense 500 keV proton beams have been investigated in the CERN 3 MeV experimental linac. Results are presented for the current transmitted through a known set of restricting apertures. These currents are considerably higher than the theoretical values for a uniform density zero

emittance beam. To explain these results in regions where the pressure is too low (10^{-6} torr) for the well-known gas neutralization mechanism, it is proposed that the beam is partially neutralized by secondary electrons produced from metallic surfaces in the beam pipe. Using a specially designed apparatus which enables electrons to be removed from the beam over a substantial fraction of its path it is found that the measured currents are more consistent with an unneutralized beam. In addition, this apparatus has enabled the determination of a very high value for the secondary electron emission coefficient for proton impact near glancing incidence. Finally the possible perturbing effect of secondary electrons on emittance measurements in low energy drift space is discussed. (auth)

50555 STUDY AND COMPENSATION OF COHERENT LONGITUDINAL INSTABILITY IN THE CERN PS. Boussard, D.; Gareyte, J.; Moehl, D. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1073-4(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Coherent longitudinal instabilities, similar to those observed in electron storage rings and in the Brookhaven AGS, occur in the CERN PS. The resulting dilution in longitudinal phase space would critically affect the luminosity obtainable in the intersecting storage rings (ISR). A theoretical study of the mechanism of this instability is presented, including the influence of the beam control loop. A compensation technique, based on introducing a difference in the synchrotron frequencies of different bunches, has been studied. It was found that in the presence of beam control the effectiveness of this cure depends critically on the pattern in which the frequency varies between the bunches. (auth)

50556 PARTICLE LOSS DURING ADIABATIC CAPTURE. Claus, J. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1075-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

In synchrotrons the horizontal betatron acceptance decreases during rf capture and early acceleration because the energy spread increases. This loss of acceptance is considered and a method for minimizing it is proposed. Consequences of application to the AGS at Brookhaven are presented. It appears that a low energy spread in the injected beam and low rates of acceleration early in the cycle are favorable. (auth)

50557 EFFECT OF A DELTA FUNCTION SEXTUPOLE FIELD ON PHASE SPACE TRAJECTORIES. Crosbie, E. A.; Khoe, T. K.; Lari, R. J. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1077-81(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

It is generally accepted that the region of phase space inside the separatrix is covered by nonintersecting invariant curves. Computer studies of a lumped element sextupole field show the existence of "islands of stability" inside the separatrix. The unperturbed tune determines the number of islands and the size and shape of the real stable region. The delta function sextupole field used for resonance extraction at the ZGS was studied. (auth)

50558 HORIZONTAL AND VERTICAL DAMPER SYSTEMS AT THE ZERO GRADIENT SYNCHROTRON AND THEIR PERFORMANCE CHARACTERISTICS. Trendler, R. C.; Bogaty, J. M. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1082-3(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Inherent to the ZGS are spontaneous intensity dependent beam size growths that can lead to precipitous beam losses. Vertical losses can occur at intensities greater than $\sim 5 \times 10^{11}$ protons per pulse. Horizontal beam losses can occur at intensities $\geq 10^{12}$ protons per pulse. The factors affecting the beam size growth, the characteristics of the signals observed, and equipment developed to control these losses are discussed. In particular, the $(1-\nu_x)$ horizontal damper and the wide band vertical damper are studied. (auth)

50559 SYNCHROTRON FREQUENCY SPLITTING IN THE SLAC STORAGE RING. Allen, M. A.; Lee, M. J.; Morton, P. L. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1084-5(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

For multibunch operation of storage rings, stabilization against longitudinal oscillations has been obtained experimentally by introducing a synchrotron frequency shift between bunches. This frequency shift was obtained by using an RF cavity operating at a harmonic of the revolution frequency but not of the main RF accelerating frequency. Initial operation of the SLAC storage ring (SPEAR) will be with a single bunch of electrons and a single bunch of positrons. It is intended to split the synchrotron frequency of the two bunches with a non-RF harmonic cavity. The effect of this cavity on the stored beam's parameters is investigated. Although primary interest is on the interacting buckets, the effect on adjacent buckets is also examined since the ring might eventually be operated with several filled buckets. (auth)

50560 BEAM–RF CAVITY STABILITY WITH FEEDBACK CONTROL IN A CIRCULAR ACCELERATOR. Lee, Martin (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1086-7(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The stability analysis of K. W. Robinson of a beam in an rf accelerating cavity has been extended to a system in which the phase and amplitude of the cavity voltage are controlled by feedback. It has been found that both the stable cavity resonance frequency range and the instability threshold can be increased by the use of feedback. (auth)

50561 PHASE SPACE ELLIPSE TRANSPORT USING TWO RAY VECTORS. Larson, J. D. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1088-9(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The method described by Lobb for calculating beam envelopes using selected initial ray vectors may be extended by applying the formalism of Norman and Moore to include a generalized description of the entire phase space ellipse (or ellipsoid) using two (or three) initial rays. All relevant information describing the ellipse is contained in a simple matrix and is accessible anywhere in the course of calculation. Existing computer codes as well as other linear ray tracing methods which do not presently exploit the power and conciseness of phase space ellipse transport may easily be adapted to this technique. (auth)

50562 DERIVATION OF SYNCHROTRON ORBIT PERTURBATIONS FROM ORBIT MEASUREMENTS. Vogel, U. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1090-1(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

A method is described where orbit deflections are used in a linear process to determine the magnitude and location of orbit perturbations along the synchrotron ring. Due to the limited number of measuring stations, the perturbations cannot be located with certainty. An analysis shows, however, that the perturbations can be located within one betatron wavelength from their true locations. The analysis shows also that an error in orbit deflection incurred by any of the measuring stations leads to errors in the perturbations of twice the magnitude but that these errors are located only within one betatron wavelength from the measuring station. The method is applied to the derivation of vertical positions of the synchrotron ring magnets. It is shown that slowly varying but otherwise random shifts can be reproduced from orbit deflection measurements. Results of magnet survey data and deflection measurements are presented and analyzed. Application of the method to the automatic correction of ring magnet alignment is also discussed. (auth)

50563 INFLUENCE OF DRIFT DISTANCE ON THE ATTAINABLE ENERGY RESOLUTION OF A BUNCHED ELECTRON BEAM. Kull, L. A.; Williams, C. B. (Gulf Energy and Environmental Systems Co., San Diego, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1097-8(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

High intensity, low energy electron beams from linear accelerators are used extensively in photofission and (γ,n) threshold reaction experiments. The degradation of the energy resolution of the beam due to the action of longitudinal space charge forces and the presence of a conducting cylinder surrounding the beam is considered. Results are presented for varying drift distances, beam currents, and phase spread of the bunch for an L-band accelerator. (auth)

50564 EFFECTS OF TRANSVERSE COUPLING IN THE SLAC STORAGE RING. Morton, P. L.; Spencer, N. C. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1099-1100(Jun 1971).

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From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

To achieve the maximum possible luminosity in the SLAC electron-positron storage ring, it is necessary to vary and control the heights of the beams. The widths of the beams are normally determined by the interplay between quantum fluctuations and radiation damping, while the heights are determined by the coupling between horizontal and vertical motion and by radiation damping. A method of controlling the beam height using skew quadrupoles to couple and motions is discussed. Beam height and width are calculated as functions of the skew quadrupole gradients, the perturbed normal modes are described, and effects on the incoherent colliding-beam stability limits are determined. (auth)

50565 POSSIBLE EMITTANCE INCREASE THROUGH FILAMENTATION DUE TO SPACE CHARGE IN CONTINUOUS BEAMS. Lapostolle, P. M. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1101-4(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The study of oscillations which can take place in a beam under space charge conditions is extended to other distributions than the one described by Kapchinsky and Vladimirsky (K.V.) in 1959. Two sets of equations similar to the ones they established can be written provided axis and emittance values are replaced by rms expressions applicable to any type of distribution. In case of a non K.V. distribution, the comparison of these sets gives differential equations relating the rms emittances to correcting terms which depend on the charge distribution inside the beam. Such equations can be used to interpret some rms emittance increases observed either with a mismatch in a smooth focusing channel or with a matched beam in an AG focusing system. The study is an attempt to explain the observed growth of emittances in high-intensity linacs. (auth)

50566 RMS ENVELOPE EQUATIONS WITH SPACE CHARGE. Sacherer, Frank J. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1105-7(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The envelope equations for a continuous beam with circular symmetry but otherwise arbitrary charge distribution, derived by Lapostolle and Gluckstern, are extended to continuous beams with elliptical symmetry, bunched beams with ellipsoidal form, and to one-dimensional motion. A rather surprising and useful result has been found for beams in free space, namely that the rms linear part of the self-field depends mainly on the rms size of the distribution and only very weakly on its exact form. Using this result, envelope equations for the rms beam size have been derived that are exact for continuous beams of elliptical symmetry, and in practice also valid for bunched beams of elliposidal form. The main restriction in applying these equations is that the time dependence of the rms emittance must be known a priori. Possible uses of the equations include the specification of stationary or matched states in the presence of space charge. Another use is the design of low-energy beam transfer lines. (auth)

50567 OVERVIEW OF HEAVY ION ACCELERATION. Beringer, Robert (Yale Univ., New Haven). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1108-9(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

The status of heavy-ion accelerator technology is briefly reviewed. (W.H.K.)

50568 REVIEW OF STRIPPING OF HEAVY IONS. Betz, Hans D. (Massachusetts Inst. of Tech., Cambridge). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1110-14(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Electron capture and loss phenomena are reviewed which occur when heavy ions penetrate through matter. Stripper targets consisting of dilute and dense gases, large molecules, and solids are examined with regard to their effects on heavy ion charge state distributions. The discussion includes semiempirical predictions for average equilibrium charge states, density effects in gases and solids, tails of charge distributions, and charge changing cross sections. (auth)

50569 ACCELERATION OF HEAVY IONS TO VERY HIGH ENERGIES AND THEIR SCIENTIFIC SIGNIFICANCE. White, M. G. (Princeton Univ., N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1115-20(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Topics include high-energy heavy ions in cosmic rays; the nuclear and elementary particle physics of the interaction of high-energy heavy ions with matter; the solid state physics of the interaction of heavy ions with matter; biophysics, biomedicine, and cancer therapy; and shielding studies, nuclear cascades, and stopping power. Beam requirements for high-energy heavy-ion studies are outlined; and the electron-ring accelerator, linear accelerator, synchrotron, and Princeton Synchrotron are discussed as heavy-ion accelerators. (W.H.K.)

50570 SOME RECENT HIGH ENERGY HEAVY ION CYCLOTRON PROJECTS. Purser, K. H. (Univ. of Rochester, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1121-30(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Basic parameters of a number of existing and proposed heavy-ion cyclotrons are listed and discussed. (W.H.K.)

50571 REVIEW OF LINEAR ACCELERATORS FOR HEAVY IONS. Main, Robert M. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 1131-6(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

During the past 5 years there has been a considerable increased interest in ions heavier than were available from existing accelerators ($M \leq 40$, Argon). The requirements for this new generation of accelerators are: ions of all masses through uranium at maximum energies of 8 to 10 MeV/A with completely variable energies above 2 MeV/A and with energy resolution better than ½%. Intensities of up to 10^{12} ions per second are required. There are presently three heavy ion accelerators in various stages of planning, design and construction, all of which use linear accelerators as a portion of the system. These are the Unilac at Darmstadt, the Helac at Heidelberg, and the SuperHilac in Berkeley. A brief discussion of these proposed accelerators is presented as well as the present status of these projects. (auth)

50572 DATA-ACQUISITION SYSTEM FOR THE NRL ELECTRON LINAC. Godlove, T. F.; Smith, G. L.; Namenson, A. I. (Naval Research Lab., Washington, D. C.). Nucl. Instrum. Methods; 95: No. 3, 595-604(1971).

A description is given of a data-acquisition system used on-line with experiments performed at the 60-MeV electron linear accelerator at the U. S. Naval Research Laboratory. The primary application of the system involves the study of neutron capture gamma rays, employing in one case a Ge(Li) detector for high resolution, and in another experiment four NaI detectors in a coincidence arrangement. In both cases time-of-flight methods are used to record the neutron energy. Both the hardware and software for these experiments are described. The design of a subsystem for automation of electron-scattering experiments is also given. Overall emphasis is on maximum flexibility and performance within a limited budget. (auth)

50573 MONTE CARLO CALCULATION OF ELECTRON PRODUCTION BY A GAMMA BEAM INCIDENT ON A THICK FOIL. Wecksung, G. W.; Walker, J. J.; Brown, R. T. (EG and G, Inc., Las Vegas, Nev.). Nucl. Instrum. Methods; 95: No. 3, 605-9(1971).

Monte Carlo methods have been applied to the study of the production of an electron current by a high energy photon beam traversing a thick foil. Both Compton scattering and the photoelectric effect are considered. Calculated sensitivities of Al and Fe as a function of thickness agree with experimental measurements to within a few percent. (auth)

50574 CONTRIBUTION TO DESIGNING A SUPERCONDUCTING MICROTRON. Alaux, A. (Univ. of Moncton, New Brunswick). Nucl. Instrum. Methods; 96: No. 1, 215-16(1971). (In French).

Aspects of the problem presented by a superconducting microtron are discussed. The variations of the physical and geometrical characteristics of niobium ellipsoid hyperboloid cavities of identical σ_0 are evaluated for frequencies varying between 0.5 GHz and 10 GHz at a temperature of 1.85 K. The results are then discussed. (auth)

50575 BREMSSTRAHLUNG METHOD FOR LOCATING ELECTRICAL BREAKDOWN IN A VAN DE GRAAFF ACCELERATOR TUBE. Gray, J. W.; Hartnell, G. W.; Legg, J. C. (Kansas State Univ., Manhattan). Contract AT(11-1)-2130. Nucl. Instrum. Methods; 96: No. 1, 217-18(1971).

A method of locating defective acceleration tube sections by measuring the energy end point of bremsstrahlung radiation from the accelerator is described. (auth)

50576 AUTOMATIC GAIN-CONTROLLED AMPLIFIER FOR BEAM PROFILE MONITORS. Rogers, P.; Potter, D.; Radeka, V. (Brookhaven National Lab., Upton, N. Y.). Nucl. Instrum. Methods: 96: No. 1, 3-8(1971).

An amplifier for beam profile scanners of the moving-wire type has been developed in which light controlled resistors vary the gain so as to provide constant peak amplitude. The peak output signal is independent of the intercepted beam current over the range 4×10^{-3} to 4×10^{-10} A. The rms noise is less than 8×10^{-12} A, and the rise time at maximum gain is 20 μsec. The control loop maintains approximately constant gain during a single scanner period, yet can change the gain over several decades in one second. At any given gain the amplifier response is linear. With this amplifier in operation, it is not necessary to change the gain manually, as the beam intensity varies over the range of beam currents commonly encountered with particle accelerators. (auth)

50577 SIMPLE ELECTRON BEAM SWITCHING PULSE GENERATOR FOR SMALL ACCELERATORS. Calverd, A. M. (Univ. of Warwick, Coventry, Eng.). Nucl. Instrum. Methods; 96: No. 1, 43-4(1971).

A simple circuit is described for producing 700 V square pulses with a p.r.r. variable between 0.1 and 400 Hz and complete coverage of duty cycle. Single-shot and continuous operation are available and the system has been found suitable for beam pulsing in a small (400 keV) electron accelerator. (auth)

50578 DSA MEASUREMENTS ON SEPARATED TARGETS. Anttila, A.; Bister, M.; Pitparinen, M. (Univ. of Helsinki). Nucl. Instrum. Methods; 96: No. 1, 141-3(1971).

Certain problems associated with stopping in DSA measurements have been investigated using the $^{26}Mg(p,\gamma)^{27}Al$ reaction and comparing lifetimes derived from these measurements with the known lifetime of the $E_x = 2210$ keV state of ^{27}Al. The effect of the quantity and composition of the collected target material on the derived lifetime was investigated by using targets prepared in different ways. The relative ranges of recoil ions were determined by implanting a small quantity of target material into the backing. The lifetime results derived using C, MgO, Mo and Ta as backing material, and corrected using measured range values are consistent with the average value obtained with other methods. (auth)

50579 DEVICE TO PRODUCE HIGH CENTER-OF-MASS ENERGY e + e COLLISIONS: ACCELERATOR BEAM COLLIDING WITH A STORED BEAM. Csonka, P. L. (Univ. of Oregon, Eugene); Rees, J. R. Nucl. Instrum. Methods; 96: No. 1, 149-55(1971).

If 20-GeV electrons from the Stanford Linear Accelerator collide with 2-GeV electrons (or positrons) circulating in the storage ring now under construction at SLAC, then the reaction center-of-mass energy will be $E_{cm} = 12.6$ GeV. The luminosity of this device is calculated to be about 2.4×10^{29} cm^{-2} sec^{-1}, and the number of $e + e \rightarrow e + e + \chi$ reactions at this energy is estimated to be about 60 h^{-1} when $\chi = \mu^+ + \mu^-$, about 10 h^{-1} when $\chi = \pi^+ + \pi^-$, and about 1 h^{-1} when $\chi = \pi^0$ or η. (auth)

50580 DISPERSION CHARACTERISTICS OF A CIRCULAR IRIS-LOADED WAVEGUIDE WITH RADIAL SLOTS ($\pi/2$ MODE). Kramskoi, G. D.; Zykov, A. I.; Grishaev, I. A.; Kolot, Z. M. Sov. Phys.-Tech. Phys. (Engl. Transl.), 16: No. 3, 439-42(Sep 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 3, 567-71(Mar 1971).

The dispersion effect of radial slots in the discs of an iris-loaded waveguide is studied for the EH_{11}, EH_{12}, EH_{21}, and E_{02} modes; the phase shift is $\pi/2$ in each section in the E_{01} mode. (auth)

50581 PRESTRIPPER FOR A LINEAR ACCELERATOR FOR MULTIPLY CHARGED IONS. Revutskii, E. I.; Bomko, V. A.; Skoromnyi, G. M.; (and others). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 3, 459-63(Sep 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 3, 591-7(Mar 1971).

A prestripper section in a linear accelerator for multiply-charged ions (10 MeV per nucleon) is described. A characteristic feature is quadrupole focusing of the beam of multiply-charged ions, $m/e \leq 4$; the rf wavelength is 2.1 m. A double drift section is used. (auth)

50582 LIMITING CURRENT IN A LINEAR ACCELERATOR WITH VARIABLE-PHASE FOCUSING. Kushin, V. V.; Dreval, I. D. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 3, 464-7(Sep 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 3, 598-602(Mar 1971).

Estimates of the limiting particle current that can be accelerated in a linear accelerator with variable-phase focusing are made by an approximate method, utilizing the method of averaging. The effect of space charge is taken into account assuming bunches in the form of uniformly charged ellipsoids of revolution that undergo periodic variation of their geometric dimensions. Estimates show that the limiting current that can be accelerated in an accelerator with variable-phase focusing is only slightly less than the proton current in a quadrupole-focusing accelerator. (auth)

50583 FOCUSING OF CHARGED PARTICLES BY MAGNETIC FIELDS. Lebedev, S. V. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 3, 423-4(Sep 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 3, 545-7(Mar 1971).

In the focusing of a paraxial beam of charged particles in magnetic fields the motion of the beam can be described by the Grinberg equations. The form of the principal trajectory for an arbitrary distribution of magnetic field along that trajectory and an arbitrary form of focusing is found. The magnetic field has translational symmetry. The spatial structure of the magnetic field is easy to find from the specified intensity distribution along the principal trajectory and the distribution obtained as a consequence of the principal trajectory. (auth)

50584 ABERRATIONS OF THREE-ELECTRODE TRANSAXIAL CYLINDRICAL LENSES. Karetskaya, S. P.; Kel'man, V. M.; Yakushev, E. M. (Inst. of Nuclear Physics, Alma-Ata, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 3, 425-8(Sep 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 3, 548-52(Mar 1971).

Quantities determining the third-order geometric aberrations of three-electrode transaxial cylindrical lenses are calculated. The results are presented graphically. (auth)

50585 STATIONARY STATE OF A POLARIZED SELF-FOCUSSING RING (ACCELERATION OF AN ELECTRON-ION BUNCH). Perel'shtein, E. A.; Yarkovoi, O. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 1, 14-20(Jul 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 1, 23-32(Jan 1971).

The acceleration of a self-focussing electron-ion bunch is discussed. It is shown that a stationary state of the ring exists in a uniformly accelerated (Moller) coordinate system if the self-focussing condition is satisfied with inclusion of gravitational forces. A mathematical model of such a ring is constructed for a particular case. (auth)

50586 TRANSVERSE OSCILLATIONS OF ELECTRONS IN THE BETATRON. Scarlat, F. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 23: No. 4, 377-86(1971). (In Rumanian).

It is well known, that the charge particles in circular accelerators perform incoherent and coherent oscillations due to the space-charge and external magnetic field. An analysis of the incoherent and coherent transverse oscillations in the presence of surrounding media is made for electrons accelerated in betatrons. The influence of the space-charge, vacuum chamber and pole pieces is considered and the current-limit theoretically attainable in a 25 MeV betatron is determined. (auth)

50587 ELECTRON BEAM BROADENING OF A 3 MeV LINEAR ACCELERATOR BY MEANS OF A QUADRUPOLAR MAGNETIC LENS. Baltateanu, N.; Nemes, Mirela; Oproiu, C. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 23: No. 4, 477-8(1971). (In Rumanian).

A simple method of broadening the 3 MeV linear accelerator beam by means of a magnetic quadrupolar lens is described. Photographic recording and dose distribution measurements across the beam were made for both normal and broadened beam. A change in the circular beam shape towards a flat ellipse was noticed, the contour estimation taking into account the same dose variation limits. The broadened beam was used in rectangular sample irradiation. (auth)

50588 0.7-MeV IRON-FREE BETATRON WITH ZERO MAGNETIC FIELD DECAY. Korobochko, Yu. S.; Shilkov, K. S. (Leningrad Polytechnic Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 3, 468-70(Sep 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 3, 603-6(Mar 1971).

Approximate design calculations for the magnetic system in an iron-free 0.7-MeV betatron with zero field decay are given. The intensity of the γ radiation for this device is compared with that of a conventional betatron. (auth)

50589 AUTORESONANT ACCELERATION OF RELATIVISTIC ELECTRONS. Ishkov, A. P. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 3, 471-3(Sep 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 3, 607-10(Mar 1971).

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The electron dynamics of an autoresonant accelerator with a relativistic injector is studied. The experimental results confirm the basic concepts of the theory. (auth)

50590 PREBUNCHING ELECTRON ACCELERATOR FOR SEMICONDUCTOR LASERS. **Bogdankevich, O. V.; Zakharova, A. N.; Olikhov, I. M.; Petrov, D. M.; Samorodova, G. A. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.): 16: No. 3, 474-8(Sep 1971).**

Translated from Zh. Tekh. Fiz.: 41: No. 3, 611-16(Mar 1971).

Calculations using a computer show that it is possible to build a prebunching electron accelerator based on the klystron principle. It is comparatively simple to obtain electron beams with energies of the order of hundreds of kilo-electron-volts with microwave power pumping in a pulse of several tens of kilowatts. The length of the current pulse is roughly an order of magnitude smaller than the period of the microwave accelerator. (auth)

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PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 48773, 48903, 49055, 49062, 49173, 50014, 50197, and 50472.

50591 (CONF-710402-(Vol.2)) NEUTRON SOURCES AND APPLICATIONS. Proceedings of the American Nuclear Society National Topical Meeting, April 19-21, 1971, Augusta, Georgia. Sessions I and II. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Apr 1971. Contract AT(07-2)-1. 289p. Dep. NTIS.

Forty articles are included; separate abstracts were prepared for 39. The remaining article on introduction to medical radiography was previously included in NSA as 25: 19034. (P.C.H.)

For abstracts of individual papers see: 48463--48467, 48776, 48903, 49173, 49174, 49222, 49224, 49251, 49252, 49284, 50197, 50592--50614, and 51156.

50592 (CONF-710402-(Vol.2), pp 117-27) MONOLAYER CERAMIC MICROSPHERE-BERYLLIUM PLATE HETEROGENEOUS ISOTOPIC NEUTRON SOURCE. Jordan, Edward D.; Carew, Thomas E.; Barkley, Barry L. (Catholic Univ. of America, Washington, D. C.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

A heterogeneous isotopic neutron source consisting of an alternating array of plates containing an alpha emitter such as ^{210}Po and Be would have the advantage of a controlled variable neutron output when the plates are moved in apposition to each other. A 6.25-cm^2 plane alpha source of 3 millicurie activity, consisting of a monolayer of Po-bearing ceramic microspheres of 50 μ diameter, affixed to the surface of an Al plate by an epoxy film, was tested to evaluate its effectiveness in producing neutrons in a Be plate through the (α,n) reaction. The alpha yield and energy spectra as a function of angle of incidence from the source were measured using a Si surface-barrier detector. Fifty percent of the alpha particles emitted in the half space above the source surface emerged from the source with energies equal to or greater than 1 MeV, and were thus effective in neutron production in Be. A neutron production rate of 110 neutrons per second per cm^2 of source surface was calculated and measured when a 10 mil thick Be plate was placed over the plate alpha source. Neutron measurements were made with a NE 213 liquid scintillation detector. It is calculated that a microsphere-plate source of optimum specific alpha activity could enhance neutron production by a factor of 30. Thus, neutron yields in excess of 1000 neutrons/sec-cm^2 are believed to be achievable by using this source design concept. (auth)

50593 (CONF-710402-(Vol.2), pp I.1-9) EXPERIMENTAL CAPABILITIES AND PERFORMANCE OF TRIGA RESEARCH AND TEST REACTORS FOR NEUTRON APPLICATIONS. Schnurer, George T.; McMain, Albert T. (Gulf Energy and Environmental Systems, Inc., San Diego, Calif.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

An overview of the various types of TRIGA reactors and their experimental facilities and performance capabilities is presented. Recently developed designs and new experimental facilities and performance capabilities are discussed in detail, and current development work in these areas is reviewed. Typical neutron research and test applications are discussed in the context of the experimental facilities and performance capabilities. Since the associated building and auxiliary equipment are important considerations in planning a neutron source facility, these aspects are also reviewed for the various types of TRIGA reactors. Similarly, operating considerations, including maintenance and staffing requirements, are discussed. (auth)

50594 (CONF-710402-(Vol.2), pp I.10-17) NBS REACTOR AS A SOURCE OF NEUTRONS. Carter, Robert S. (National Bureau of Standards, Washington, D. C. Inst. for Materials Research).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

The NBS Reactor (NBSR) is a 10-MW reactor moderated and reflected by D_2O. The fuel elements are located seven inches apart in hexagonal arrays around experimental irradiation facilities. In order to support the broad range of research programs typical of a laboratory like the NBS, the reactor has extensive in-core, beam-tube, and pneumatic-tube facilities. Thermal-neutron fluxes in the beam tubes and higher-flux irradiation facilities are about 10^{14} n/cm^2-s. Several unique features of the NBSR contribute to its versatility. They include a thermal column with cadmium ratios for gold foils as high as 30,000 to 1, a split core to minimize the intensity of very-high-energy neutrons in the beam tubes, and a cold-neutron source to enhance the intensity of very-low-energy neutrons available for certain inelastic scattering experiments. Extensive, automated experimental facilities were developed to utilize fully the neutron beams and irradiations provided by the NBSR. (auth)

50595 (CONF-710402-(Vol.2), pp I.22-32) CONTROL OF NEUTRON BEAMS BY VIBRATING CRYSTALS. Jacobs, Alan M.; Kenney, Edward S.; Jeffries, Jeffrey D. E. (Pennsylvania State Univ., University Park. Dept. of Nuclear Engineering).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

The preponderance of work on neutron diffraction has been perpetuated in the investigation of crystal structure. Recently (1965), it was suggested that diffracted neutron beams could be modulated in intensity if the diffracting crystal was mechanically vibrated. This modulation was subsequently observed along with a rather large increase in mean intensity (up to a factor of 60). The historical development of measurements and interpretations of the vibration-induced phenomena is reviewed. An analysis, described in detail, is along conventional crystallographic lines with emphasis on the neutron effects of interest. Neutron-diffraction enhancement and modulation are traced to the effects of location-dependent mechanical strain on the ranges of neutron energy and direction that satisfy the Bragg condition. Conjectures are made regarding further investigations and applications of neutron diffraction by vibrating crystals. These include areas of thermal-neutron-beam-intensity enhancement, containment, focusing, and intensity modulation. (auth)

50596 (CONF-710402-(Vol.2), pp I.33-8) UNIQUE RESEARCH POTENTIAL OF NEUTRON PULSES FROM NUCLEAR EXPLOSIONS. Carter, Robert L. (Missouri Univ., Columbia).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

International political negotiations are now being conducted that may result in an agreement to suspend all further tests using nuclear explosions. It seems appropriate that the art of explosive sources should be examined at this time for nonweapons-related applications. It is pointed out that underground explosive neutron sources offer workers in other fields of nuclear science and engineering unique approaches to certain unanswered questions through appropriately tailored experiments. The permitted extension in flux intensity by a factor of 10^6 may be used to help characterize irradiation annealing mechanisms in solids. The 10^{-7}-second duration of a derivative fission particle-pulse allows experimental examination of the immediate excitation states in fuel-bearing materials. With regard to fast breeder reactor structural-materials problems, it is proposed that cross sections for $(n_{th} + n_f, \alpha)$ reactions in constituent atoms of structural materials be examined for a wide variety of nuclides by using an underground explosive nuclear source of fast neutrons. The potential of explosive nuclear sources for studies of neutrino interactions should be explored further. (auth)

50597 (CONF-710402-(Vol.2), pp I.39-49) DEVELOPMENT OF AN INTENSE PULSED 14-MeV NEUTRON SOURCE. Gates, Duane C.; Demeter, Laszlo J. (Physics International Co., San Leandro, Calif.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

Initial results are presented for a 500-kilojoule, dense plasma focus (DPF) device filled with a 50%-50% mixture of tritium and deuterium. The DPF gun is a coaxial plasma accelerator, which converts a fraction of the stored magnetic energy behind a moving current sheet into plasma energy. The axisymmetric current sheet is initiated on, and lifted up from, a breech insulator between the electrodes and then accelerated toward the tip of the center electrode by magnetic forces. There, a violent radial (Z pinch) collapse generates a short-lived, dense, high-temperature plasma (DPF) wherein ^{3}H(d,n)^{4}He reactions produce the outburst of 14-MeV neutrons. The diameters of the coaxial electrodes were 10 and 12

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inches, and the operating pressure was typically 8 to 10 torr. The plasma gun was energized by a 160-capacitor, 20-kv, 2.24-mF bank discharged through 20 vacuum switch gaps. The current sheet reached its peak of 3 MA at 3.2 μsec, then collapsed to 2.2 MA at 4.8 μsec; a typical neutron pulse width of 100 nsec (fwhm) was produced. Following diagnostics were used: scattering-corrected silver-activation detectors for yield; cadmium-shielded sulphur tablets for fluence; and photodiode-scintillator units, enclosed in thick lead, for pulse-width information. Maximum yield of 6×10^{12} neutrons/pulse and fluence of 10^{11} neutrons/cm^2 were recorded during the initial 20-pulse operation. Neutron yields from reactions ^{3}H(d,n)^{4}He and ^{2}H(d,n)^{3}He are compared for the device. (auth)

50598 (CONF-710402-(Vol.2), pp I.50-5) USING A MESON FACTORY AS AN INTENSE PULSED NEUTRON SOURCE. Fullwood, Ralph R. (Los Alamos Scientific Lab., N. Mex.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

The Weapons Neutron Research (WNR) facility is proposed for adapting the Los Alamos Meson Physics Facility (LAMPF) to pulsed neutron production in the range 1 to 20 MeV. Intensity estimates are given and associated problems are discussed. (auth)

50599 (CONF-710402-(Vol.2), pp I.56-60) GAS TARGET SOURCE FOR FAST NEUTRON CANCER THERAPY. Kelsey, C. A.; Boone, M. L. M.; Hevezi, J. M.; Wiley, A. L.; Spaiek, G. C.; Forsen, H. K.; Winter, W. R. (Wisconsin Univ., Madison).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

Experimental and theoretical studies are underway to investigate the use of a differentially pumped gas target as a source of fast neutrons for cancer therapy. A target containing tritium gas at a pressure of 10 mm Hg bombarded by 16 ma of 250-keV deuterons should produce 10^{13} n/sec. Gas flowing out through the target entrance aperture will be returned to the target through a pumping recirculation system. Current efforts are utilizing proton and deuteron beams with hydrogen and deuterium targets to study the focusing and cooling requirements of the system. Present results indicate a gas target producing 10^{13} n/sec for clinical use is technically feasible. (auth)

50600 (CONF-710402-(Vol.2), pp I.72-83) PREPARATION OF INDUSTRIAL ^{252}Cf NEUTRON SOURCES AT SAVANNAH RIVER LABORATORY. McDonnell, W. R.; Boulogne, A. R.; Faraci, J. P.; Peterson, S. F.; Dahlen, B. L.; Mosley, W. C.; Mahoney, D. J.; Whatley, V. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

About 50 neutron sources containing up to 5 mg of ^{252}Cf were prepared at SRL for industrial applications in the ^{252}Cf market evaluation program. Most of the sources were prepared by oxalate precipitation and calcination to form californium oxide. The oxide was contained within Pt–10% Rh inner capsules and Type 304L stainless steel or Zircaloy-2 outer capsules. Feed received recently from ORNL as the product of the calcination of ^{252}Cf-loaded cation exchange resin, and from SRL separations operations as purified ^{252}Cf solution, had 4 to 5 parts cationic impurities per part ^{252}Cf. This feed was used for source preparation without further purification. Techniques and facilities were developed to minimize radiation exposures incurred during source fabrication and handling operations. Interfering gamma radiation from the stainless steel capsules was substantially reduced by substituting Zircaloy-2 capsules for sources to be used for prompt gamma activation analyses; several other suitable capsule materials were also defined. Assessments of the chemical stability of the californium oxide, the potential for deleterious interactions between source components, and the heat transfer and strength capabilities of the capsules indicated that high integrity containment of the ^{252}Cf in the sources should be maintained under many adverse conditions (auth)

50601 (CONF-710402-(Vol.2), pp I.84-9) EFFECTS OF SOURCE ENCAPSULATION MATERIALS ON THE THERMAL-NEUTRON FLUX FROM A ^{252}Cf SOURCE IN A WATER MODERATOR. Kok, Kenneth D.; Artigas, Ricardo; Ray, Joseph W. (Battelle Memorial Inst., Columbus, Ohio).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

Many possible applications of small neutron sources require the optimization of the thermal flux from the source. Since these are fast-neutron sources, the peak thermal flux available from the source occurs in the moderator surrounding the source. The material in which the source is encapsulated can have an effect by perturbing the thermal flux around the source and decrease the peak flux available. Experimental measurements were carried out using a ^{252}Cf source encapsulated in a Pt–Rh inner capsule and a Type 304 stainless steel outer capsule. The outer capsule dimensions were 0.375 inch OD and 1.25 inches long. The calibrated source strength was 2.385×10^9 neutrons/second. Flux measurements made by using gold-foil activation techniques gave a peak flux of 2.4×10^7 neutrons/cm^2-sec approximately 0.5 inch from the source. Calculations were made using the two-dimensional transport code DØT to determine the effect of encapsulation material on thermal-neutron flux and flux distribution in a water moderator. Calculations were made for the actual encapsulation material (Pt–Rh inner, stainless steel outer) and for capsules made entirely of aluminum. These calculations indicate a 20 percent higher thermal-neutron flux with the aluminum capsule than with the Pt–Rh/stainless steel capsule. (auth)

50602 (CONF-710402-(Vol.2), pp I.90-9) RECENT DEVELOPMENT IN (α,n) SOURCES. Ansell, Kenneth H.; Hall, Edward G. (Radiochemical Centre, Amersham (England)).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

For many applications the conventional type of (α,n) neutron source is perfectly satisfactory. However, with the development of new techniques, sources with alternative constructions are required. This paper describes recent developments in neutron source design that were carried out in the UK to meet this new situation. As an alternative to the simple cylindrical source, there is a growing demand for annular and line sources for industrial and research applications. For medical use a ^{242}Cm–Be needle may have some advantages, and a source similar to a conventional radium needle was produced. Sources with different physical properties were developed in addition to sources with different external shapes. The incorporation of the active material in ceramic form can give increased source safety where the source is used in high risk environmental conditions. The development of some sources is discussed, and the results of integrity tests are presented. For instrument calibration, the ability to switch the neutron output may be an advantage. The construction of such a source presents an interesting problem, and one possible solution to this problem is discussed. It is possible that in the future ^{252}Cf may meet many of the demands for high activity neutron sources, but the long half-lives of nuclides like ^{241}Am and ^{238}Pu make them very suitable for use in instrumentation sources, and the demand for (α,n) neutron sources is likely to continue for many years. (auth)

50603 (CONF-710402-(Vol.2), pp I.100-11) HIGH INTENSITY (α,n) SOURCES. Ansell, Kenneth H.; Hall, Edward G. (Radiochemical Centre, Amersham (England)).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

Radioisotope neutron sources have been used extensively in the field of power reactors for neutron flux measurements during start-up, reactor design studies, and in teaching reactor technology. All (α,n) neutron sources consist of a mixture of an alpha emitter and a light element target, usually beryllium. Experience in the UK is that, for (α,n) sources with outputs above 10^8 n/sec, the nuclides selected are ^{210}Po, ^{228}Th, and ^{242}Cm. ^{210}Po and ^{228}Th have been used in high-intensity neutron sources for more than a decade but ^{242}Cm has only recently become commercially available. The use of ^{210}Po is likely to decline, and this paper concentrates on sources containing ^{228}Th and ^{242}Cm. These nuclides are produced by the reactor irradiation of ^{226}Ra and ^{241}Am, respectively. The problems associated with these irradiations and the subsequent chemical processing to yield multicurie quantities of pure nuclide are discussed. The design, manufacture, and testing of ^{228}Th–Be and ^{242}Cm–Be neutron sources with outputs up to 1.2×10^9 n/sec which are safe for reactor use over a number of years are outlined. The properties of ^{228}Th–Be and ^{242}Cm–Be including neutron spectra are given. (auth)

50604 (CONF-710402-(Vol.2), pp I.112-16) EVALUATION OF A ^{244}Cm–Be NEUTRON SOURCE FOR ACTIVATION ANALYSIS. Wahlgren, Morris A.; Stewart, Donald C. (Argonne National Lab., Ill.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

A ^{244}Cm–Be neutron source has recently been fabricated at ANL by Stewart, Horwitz, Youngquist and Wahlgren [Nucl. Appl. Tech., 9: 875(1970)]. A 0.64-gram quantity of 99 atom % pure ^{244}Cm was mixed with -325 mesh Be metal in a 1:100, Cm:Be ratio and compressed at 10,000 psi to produce the source. This source has a half-life of 17.6 years and has a low gamma-ray background. The neutron emission rate was measured to be 1.2×10^8 neutrons/

second. The gamma radiation from the bare source and from the water or paraffin-moderated source was measured with a 20-cm^3 Ge(Li) detector. Experimental detection sensitivities in a rabbit irradiation facility were obtained for the light elements, where (n,p) and (n,α) reactions occur. Some comparative data taken with a ^{252}Cf source of nearly equivalent intensity in the same assembly are also presented. When ^{244}Cm becomes readily available as a by-product of power reactor fuel reprocessing, these sources will be very useful for certain applications because of the neutron spectral characteristics, the convenient half-life, and the relatively low cost where long-term utilization is possible. (auth)

50605 (CONF-710402–(Vol.2), pp I.136-41) FLUX ENHANCEMENT WITH A ^{252}Cf SOURCE IN A SUBCRITICAL ASSEMBLY. Currie, R. L.; McCrosson, F. J.; Parks, P. B. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

The spontaneous-fission neutrons emitted by ^{252}Cf can be thermalized by surrounding the source with a neutron-moderating material. If a subcritical multiplying system is substituted for the simple moderator, the thermal flux can be enhanced. To determine the extent of this enhancement, discrete-ordinates codes were used to calculate neutron fluxes in $^{233}U-H_2O$ and $^{235}U-H_2O$ solutions containing a central ^{252}Cf neutron source. Compared to a non-multiplying medium of H_2O, spherical $^{233}U-H_2O$ solutions with $k_{eff} = 0.98$ can enhance the thermal flux at the source by a maximum factor of 6.4; similarly $^{235}U-H_2O$ solutions can increase the flux by a maximum factor of 4.8. The dependence of the enhanced thermal flux on nuclear parameters was estimated with two-group diffusion theory to be $M/\nu\sigma_f m_f$ where ν is the average number of neutrons per fission, σ_f is the microscopic fission cross section for the thermal group, m_f is the mass of fissile material, and M is the integral source multiplication. The S_n calculations were extended to cylindrical multiplying systems to examine the effects of reentrant ports and thus to be more directly applicable to activation analysis and neutron radiography. (auth)

50606 (CONF-710402–(Vol.2), pp I.142-6) COMPARISON OF NEUTRON SOURCE COSTS. Heinrich, L. A. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

A general method for calculating the cost of maintaining isotopic neutron sources is developed. The method is oriented toward industrial applications and includes costs incurred by source decay, encapsulation, and shipping, as well as interest on investment. Direct comparison between sources with different nuclear characteristics is facilitated by expressing source costs as the average yearly cost over a ten-year period, optimizing individual source use times to minimize costs, and expresssing costs as a function of source strength. Source characteristics pertinent to specific applications, such as physical size and heat generation, must also be considered, in addition to the maintenance costs. Under pricing assumptions thought to be representative of conditions over the next ten years, an application of the method to the current complement of isotopic neutron sources indicates that $^{238}Pu-Be$ sources are the most economical below a source strength of about 7×10^8 n/sec and that ^{252}Cf sources are the most economical above that level. (auth)

50607 (CONF-710402–(Vol.2), pp I.147-53) PROTON RECOIL MEASUREMENTS OF THE PuBe SOURCE NEUTRON SPECTRA. Alexander, Roger L.; Shook, Donald F.; Ford, C. Hubbard (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

The spectrum of a 5-Ci Pu–Be neutron source was measured from 40 to 800 keV. The measurement was made using a spherical proportional counter containing hydrogen at a pressure of 4 atmospheres. Pulses due to gamma-ray interactions in the chamber were distinguished by rise-time analysis using a two-parameter pulse-height analyzer. The proton recoil spectrum was analyzed using a code written by Benjamin that accounts for contributions to the proton recoil spectrum from neutrons of energy greater than that to be analyzed [AWRE Report No. 09/68]. The proportional-counter measurement is combined with a recent liquid-scintillator measurement [NASA JM X-52828] to give a complete spectrum. Good agreement exists between the two measurements in the region of overlap from 500 to 800 keV. The proportional-counter data show that the flux is fairly smooth and flat in the region from 40 to 800 keV. The present measurements indicate a neutron yield below 1 MeV for this source of 20.2 ± 3.9 percent. (auth)

50608 (CONF-710402–(Vol.2), pp I.154-9) ABSOLUTE MEASUREMENTS ON THERMAL NEUTRON FLUXES PRODUCED IN WATER BY (d,d) AND (d,t) REACTIONS WITH 150 keV DEUTERONS. Holland, L.; Walker, J. (Birmingham Univ. (England). Dept. of Physics).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

A small accelerator producing 150-keV deuterons was used with conventional adsorbed deuterium and tritium targets to produce neutrons that were moderated in ordinary water. The thermal-neutron flux distributions were measured with a small scintillation detector, which was calibrated against the activation of thin foils of gold; in turn, the gold foils were calibrated in a standard flux of thermal neutrons. Absolute values of the fluxes per fast neutron injected were obtained by an associated-particle measurement of the actual target yield. Simple age-diffusion calculations were made for both cases and gave flux distributions in reasonable agreement with the experimental results for the (D-D) neutrons but more refined computational methods are required for the (D-T) case; results of an S-N computation are included for the latter.

50609 (CONF-710402–(Vol.2), pp I.160-5) REACTOR AND NEUTRON PHYSICS APPLICATIONS OF CALIBRATED NEUTRON SOURCES. De Volpi, A.; Porges, K.; Karam, R.; Poenitz, W.; Cox, A.; Bretscher, M.; Redman, W. C.; Carpenter, S. (Argonne National Lab., Ill.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

Neutron sources calibrated to high accuracy were employed in a number of reactor and neutron physics applications. Three categories of use can be distinguished: for integral measurements in critical facilities (such as $\bar{\alpha}$, β_{eff}, and the normalization integral); directly for differential cross-section measurements (ν and η); and indirectly in other neutron physics experiments (branching ratios and flux calibration). Although the initial need for independent absolute neutron capability arose from requirements of high accuracy in measurements of the neutron yield from fission (ν), both the standardized sources and the calibration facility have benefited other users. Extensive efforts in verification of the various procedures leading to absolute neutron emission rates permit calibration to ±0.4%. Among those independent efforts going into reducing the quoted error were studies of parasitic absorption of high-energy neutrons in sulfur and oxygen, thermal absorption in sulfur and hydrogen, neutron escape, source and cavity self-absorption, and absolute detection of manganese activity—all carried out at differing concentrations and for sources having a wide range of neutron emission spectra. (auth)

50610 (CONF-710402–(Vol.2), pp I.166-9) NEUTRON SPECTRUM FROM A RADIOACTIVE $^{210}Po-Li(\alpha,n)$ SOURCE. Geiger, Klaus W.; van der Zwan, Len (National Research Council of Canada, Ottawa (Ontario). Div. of Physics).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

The neutron spectrum of a $^{210}Po-Li$ (α,n) source was determined by a ^3He proportional counter, a stilbene scintillation detector, and a calculation using the $^7Li(\alpha,n)^{10}B$ differential cross section as measured with an accelerator beam. The spectrum rises to a maximum at 0.1 MeV and then smoothly decreases to an endpoint at 1.32 MeV. It is believed that the calculated spectrum is the most accurate one but, on the other hand, it did not include the effect from the scattering of neutrons within the source capsule. The spectrum taken with the ^3He counter needed rather large corrections for geometric effects; the stilbene detector did not permit establishing the spectrum for neutron energies below 0.5 MeV. (auth)

50611 (CONF-710402–(Vol.2), pp I.170-1) EVALUATION OF THE NEUTRON SOURCE ABSORPTION CORRECTION IN A MANGANOUS SULFATE BATH. Spiegel, Valentine Jr. (National Bureau of Standards, Washington, D. C. Center for Radiation Research).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

A program was written and experimentally verified for the correction to the Manganous Bath Technique for thermal-neutron self-absorption in spherical and cylindrical neutron sources. The correction is generally small for most absolutely calibrated neutron sources, but may be as large as four or five percent for some commercially available sources with large thermal-neutron cross sections. Neutron multiplication in Pu–Be sources may partially compensate or even overcompensate for neutron absorption. The thermal-neutron flux at the source location, the source dimensions,

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and the macroscopic fission and absorption cross sections for all materials in the source are required as program input. (auth)

50612 (CONF-710402-(Vol.2), pp I.182-6) DOSE RATE ESTIMATION FOR NEUTRON SOURCE SHIELDING AND APPLICATIONS. Hootman, H. E.; Stoddard, D. H. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

The ANISN discrete-ordinates code, which solves the energy-dependent transport equation from coupled neutron–gamma cross section sets, was used to generate dose attenuation curves for common shielding materials. Calculated data are furnished for a ^{252}Cf fission source, a ^{124}Sb–Be photoneutron source, and a ^{238}Pu–Be (α,n) source. (auth)

50613 (CONF-710402-(Vol.2), pp I.187-95) CALCULATED AND MEASURED EFFECTIVENESS OF ^{252}Cf SOURCE SHIELDING. Stoddard, D. H.; Moyer, R. A. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

The discrete-ordinates computer code ANISN was used to evaluate effectiveness of shields and casks for the shipment of ^{252}Cf sources. Gamma and neutron dose-rate equivalents radiating from shields and casks containing ^{252}Cf sources were measured with radiological instruments and thermoluminescent dosimeters. In most instances, the calculated data agree within a factor of two with the measured data. Differences generally indicate that the calculations are conservative. (auth)

50614 (CONF-710402-(Vol.2), pp I.196-203) DESIGN AND CONSTRUCTION OF A VERSATILE ^{252}Cf NEUTRON SOURCE SHIELD AND EXPERIMENTAL FACILITY. Gage, Stephen J.; Draper, E. Linn Jr.; Bouchey, Gary D.; Day, Richard R. (Texas Univ., Austin. Nuclear Reactor Lab.).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

The design and construction of a facility that combines the functions of a shipping container, experimental utilization assembly, and biological radiation shield for a 1000-microgram ^{252}Cf neutron source is described. The facility is a right cylinder, 52″ high and 48″ in diameter, pierced at the midplane by four stepped beamports that converge to a central cavity. A water-extended polyester (WEP) resin with composition of 30% resin and 70% water was used to cast the bulk of the shield with the internal beamport and central cavity structure formed of welded polyethylene and the exterior formed of rolled 16-gauge sheet steel. The fast-to-thermal flux ratio near the source can be maximized by lining the central cavity with boron or cadmium, or the neutron energy spectrum can be degraded by inserting spectrum-tailoring materials into the cavity. The facility satisfied Department of Transportation regulations for a 7A Type A shipping container, and is proving to be very useful for a variety of application experiments under the USAEC Market Evaluation Program. (auth)

50615 (CONF-710402-(Vol.3)) NEUTRON SOURCES AND APPLICATIONS. Proceedings of the American Nuclear Society National Topical Meeting, April 19–21, 1971, Augusta, Georgia. Sessions III and IV. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Apr 1971. Contract AT(07-2)-1. 173p. Dep. NTIS.

Nineteen articles are included; separate abstracts were prepared for each. (P.C.H.)

For abstracts of individual papers see: 48468–48474, 48602, 48603, 48726, 48727, 48759–48763, 48953, 48954, and 51157.

50616 FAST NEUTRON FLUX CLOSE TO THE NEUTRON GENERATOR TARGET. Kishikawa, T.; Shinomiya, C. (Kumamoto Univ., Japan). Radiochem. Radioanal. Lett.; 7: No. 1, 15-21(15 Jun 1971).

The fast neutron flux in the vicinity of a neutron-generator target has been derived by pure geometric configuration. The results are compared with those published by others. The results seem to represent axial neutron flux distribution. (auth)

50617 TRANSMISSION AND REFLECTION COEFFICIENTS FOR SLAB GEOMETRY. El Wakil, S. A. (Central Research Inst. for Physics, Budapest). Atomkernenergie; 17: No. 4, 241-4(Jul 1971).

The method of boundary sources is used to obtain the reflection and transmission coefficients for slab geometry. The resultant are a set of linear equations obtained on the bases of the integral definition of both coefficients. (auth)

50618 NEUTRON ENERGY DISTRIBUTION OF A SEALED NEUTRON GENERATOR TUBE. Wieldraaijer, J.; Hoogerbrug, H. R. (Philips Gloeilampenfabrieken, Eindhoven, Netherlands). Nucl. Instrum. Methods; 95: No. 1, 119-24(1971).

The neutron energy distribution (in the forward direction with respect to the ion-beam) of a sealed neutron generator tube is calculated for two assumed deuterium-tritium distributions in the target; the calculation is performed for all projectiles occurring in the ion beam. The energy distribution, especially on the high energy side, is dependent on the assumed hydrogen distribution in the target. For both distributions used in this calculation, the average energy is about 14.7 MeV and the maximum energy 15.1 MeV. (auth)

50619 NEUTRON INTENSITIES FROM PROTON BOMBARDED THICK LITHIUM TARGETS. Theobald, J. P.; Migneco, E.; Cervini, C. (EURATOM, Geel, Belg.). Nucl. Instrum. Methods; 95: No. 1, 1-4(1971).

The differential neutron yield dN/dE_n as a function of the laboratory angle ϑ is calculated for the $^7Li(p,n)^7Be$ reaction between 2.05 and 2.45 MeV and the $^7Li(p,n)^7Be^*$ reaction between 2.89 and 3.47 MeV proton energies. The result, together with tables, which give the neutron energies E_n as a function of proton energy E_p and laboratory angle ϑ, is of use for feasibility studies of neutron time-of-flight experiments. (auth)

50620 MULTIPLE SCATTERING OF THERMAL NEUTRONS BY A PERFECT CRYSTAL. I. GENERAL FOUNDATIONS. Lenk, R.; Solbrig, H. (Technische Hochschule, Karl-Marx-Stadt, Ger.). Phys. Status Solidi (b); 46: No. 1, 273-82(1 Jul 1971).

The wave function of a neutron in a regular crystal is built up as a superposition of a primary plane wave and outgoing spherical waves. The elastic scattering properties of the nuclei are given exactly by their complex scattering amplitude f. It is carefully distinguished between the total wave field and the arriving field at any scattering center. This results in a correct and consistent description of absorption effects. In the case of an infinite-crystal slab, the construction of the wave field is simplified by a lattice plane method: all the spherical waves coming out from such an infinite lattice plane add to plane waves, and most of them are strongly damped with increasing distance from the plane. The undamped waves give the far-field, which contains all the interesting informations about the collective interference effects. Neglect of the damped waves gives a good starting point for the approach given in the following two parts of this paper. (auth)

50621 THERMAL-NEUTRON DIFFUSION PARAMETERS IN WATER BY THE POISONING METHOD. Martinho, E.; Costa Paiva, M. M. (Laboratorio de Fisica e Engenharia Nucleares, Sacavem, Portugal). Nucl. Sci. Eng.; 45: No. 3, 308-13(Sep 1971).

Diffusion parameters of thermal neutrons in water were determined from diffusion length measurements in 22 boron-poisoned aqueous solutions. A uniform plane source of thermal neutrons and a parallelepiped polymethyl methacrylate container having a buckling of $B^2 = 9.1 \times 10^{-2}$ cm^{-2} were used. The derived values of the diffusion parameters of thermal neutrons in water at 22°C are

$$D_0 = 36304 \pm 180 \text{ cm}^2/\text{sec}$$

$$C = 3213 \pm 110 \text{ cm}^4/\text{sec}$$

$$F = 373 \pm 97 \text{ cm}^6/\text{sec}$$

These results are found to be in good agreement with Dorning's recent calculations. (auth)

50622 MATRIX REIMANN-HILBERT PROBLEMS RELATED TO NEUTRON TRANSPORT THEORY. Burniston, E. E. (North Carolina State Univ., Raleigh); Siewert, C. E.; Silvennoinen, P.; Zweifel, P. F. Nucl. Sci. Eng.; 45: No. 3, 331-2(Sep 1971).

50623 NUCLEAR CROSS-SECTION LIBRARY OF NEUTRON INDUCED REACTIONS FOR REACTOR DESIGN. Garg, S. B.; Rostogi, B. P. (Bhabha Atomic Research Centre, Bombay). pp 106-8 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

50624 INTERNATIONAL INTERCOMPARISON OF THERMAL NEUTRON FLUX DENSITY STANDARDS USING $4\pi\beta-\gamma$ COINCIDENCE TECHNIQUE. Shahani, M. G.; Sharma, D. (Bhabha Atomic Research Centre, Bombay). pp 279-84 of Proceedings of

the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear Physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208–(Vol. 2).

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Refer also to abstracts 50156–50158, 50723, 50821, and 50822.

50625 (JINR-P-1-5832) MEASUREMENTS OF DIFFERENTIAL CROSS SECTIONS FOR THE REACTION (π^-,2p) ON ^{6}Li NUCLEUS AT THE π-MESON ENERGY E = 85 ± 4 MeV. Nadezhdin, V. S.; Petrov, N. I.; Satarov, V. I.; Vzorov, I. K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

The differential cross sections $d^2\sigma/d\omega_1 d\omega_2$ for the reaction (π^+,2p) on ^{6}Li nuclei at E = 85 MeV were measured for some sets of values for fast proton emission angles with respect to the π^+-meson beam direction. By summing the measured cross sections over one of the solid angles the cross sections $(d\sigma/d\omega_1)(\theta_1 = 79°30')$ were found which refer to different excitation states of a residual nucleus. (auth)

50626 (ORNL-TM-3484) THE ^{3}He(d, t)2p REACTION AT A CENTER-OF-MASS ENERGY OF 23.5 MeV. Rutkowski, Robert William (Oak Ridge National Lab., Tenn.). Aug 1971. Contract W-7405-eng-26. 101p. Dep. NTIS.

Thesis.

Energy spectra from the reaction ^{3}He(d,t)2p were measured for 24 angles at a center-of-mass energy of 23.5 MeV. In order to analyze these data with the distorted-wave Born approximation, optical potentials were obtained by fitting d + ^{3}He elastic scattering at the same energy. The spectra and angular distributions for the reaction were analyzed with the formulation of Henley et al. The spectrum at 10.2° yields a value for the size of the ^{3}He wave function consistent with that obtained from electron scattering. The zero-range approximation represents the energy spectra well, except at very large angles; but the calculated angular distribution does not reproduce the observed structure at forward angles. Inclusion of finite-range effects improves the angular distribution markedly, but at the expense of the forward-angle spectra. Comparison of the scattering and reaction angular distributions, as well as a study of the spectral shapes near 180°, indicates that pick-up is predominant at forward angles while no one mechanism is of greatest importance at back angles. (auth)

50627 EXCITATION FUNCTIONS OF REACTION ^{3}H(t,2n)^{4}He AT 0^0 ANGLE IN THE ENERGY RANGE 40 TO 200 keV. Strel'nikov, Yu. V.; Abramovich, S. N.; Morkin, L. A.; Yur'eva, N. D. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 1, 165-8(Jan 1971). (In Russian).

Excitation functions of the reaction ^{3}H(t,2n)^{4}He at triton energies below 200 keV were measured by the neutron yield using a long counter. The tritons were accelerated by a 2.5-MeV electrostatic generator. The results of the study indicated the absence of resonances in nuclear interactions in collisions with tritons at the energies studied. (R.V.J.)

50628 ASYMMETRY OF PROTONS FROM THE BREAK-UP OF VECTOR-POLARIZED DEUTERONS ON ^{4}He. Keller, L. G.; Haeberli, W. (Univ. of Wisconsin, Madison). Nucl. Phys.; A172: No. 3, 625–32(1971).

The azimuthal asymmetry of protons from the break-up of vector-polarized deuterons on ^{4}He has been measured at 8.5, 10 and 11 MeV deuteron energy for laboratory angles between 17.8° and 88.2°. The observed asymmetry for a given bombarding energy and reaction angle depends strongly on the energy of the outgoing proton. Large asymmetries were observed in the energy region of the proton spectrum which corresponds to the formation of ^{5}He in the unbound $3/2^-$ state at 0.96 MeV. The results are compared to calculations which assume that the reaction proceeds by (d,p) stripping to an unbound state. The analysis reproduces the observed asymmetries only qualitatively. (auth)

50629 POSSIBLE INTERPRETATION OF DISTINCT VIOLATION OF THE ISOSPIN INVARIANCE OBSERVED IN THE ^{2}H(α,t)^{3}He REACTION AT $E_{c.m.}$ = 27.4 MeV. Murakami, A. (Saga Univ., Japan). Phys. Lett.; 36B: No. 3, 165–8(6 Sep 1971).

A possible interpretation is presented for asymmetry of the angular distribution for the reaction ^{2}H(α,t)^{3}He at $E_{c.m.}$ = 27.4 MeV observed by Gross et al. (Phys. Rev. Letters, 24, 473 (1970)). It is suggested that the asymmetry results from isospin mixing (^{11}F + ^{33}F) in the intermediate state. (auth)

50630 ABSOLUTE CALIBRATION OF SPIN-1/2 POLARIZATION. Plattner, G. R. (Univ. of Basel); Bacher, A. D. Phys. Lett.; 36B: No. 3, 211–14(6 Sep 1971).

It is shown that the polarization $P(\theta,E)$ of spin-$\frac{1}{2}$ particles scattered from particles without spin must reach the value $|P| = 1$ at some point (θ,E_1), if the scattering amplitudes fulfill certain conditions at two other energies $E_0 < E_1$ and $E_2 > E_1$. As examples, nucleon-^{4}He and ^{3}He–^{4}He elastic scattering are investigated in this respect. (auth)

50631 VERTEX CONSTANTS FOR AN ALPHA PARTICLE. Baryshnickov, A. G.; Blokhintsev, L. D. (Moscow State Univ.). Phys. Lett.; 36B: No. 3, 205–7(6 Sep 1971).

Assuming that the main contribution to the amplitudes of virtual decay $\alpha \rightarrow d + d$ and $\alpha \rightarrow t(\tau) + p(n)$ comes from the nearest singularities corresponding to triangular Feynman graphs, the relation between vertex constants for these processes has been found. Theoretical estimates are compared with the results of analysis of certain nuclear reactions in the framework of the peripheral model. (auth)

50632 POLARIZED NEUTRONS FROM THE ^{3}H(p,n)^{3}He REACTION. Cramer, D. S.; Cranberg, L. (Univ. of Virginia, Charlottesville). Nucl. Phys.; A171: No. 1, 59–64(1971).

The polarization of neutrons from the ^{3}H(p,n)^{3}He reaction was measured at 31.6° in the lab (approximately 45° in the center of mass) by using ^{4}He in the form of a pressurized gas as a polarimeter in conjunction with a time-of-flight spectrometer. Polarization is attributed to the interference of the $^3P_0$ and $^3P_2$ waves, forming the T = 0; $J^\pi = 0^-$, 2^- states in ^{4}He at 21.4 and 22.2 MeV, respectively. Observed polarizations are larger than those predicted by theory and indicate a needed adjustment of the spacing and position of the above T = 0 levels. (auth)

50633 MICROSCOPIC CALCULATION OF THE CHARGE FORM FACTOR OF ^{4}He. Wright, L. E. (Ohio Univ., Athens); Dieperink, A. E. L. Phys. Rev., C; 4: No. 2, 355–62(Aug 1971).

The charge form factor of ^{4}He is calculated using the nonlocal nucleon–nucleon interaction constructed by Kahana, Lee, and Scott [Phys. Rev., 185: 1378 (1969)]. In the framework of perturbation theory one-particle–one-hole (1p–1h) and two-particle–two-hole (2p–2h) excitations are taken into account, and the defect wave function is obtained. The calculation is in qualitative agreement with the experimentally determined form factor in that the distinctive diffraction minimum is predicted, but beyond momentum transfer of 3 fm^{-1} the calculated form factor is too small. The agreement is improved if the 1p–1h terms are omitted. (auth)

50634 EXCHANGE PROCESSES IN n + α SCATTERING. Thompson, D. R.; Tang, Y. C. (Univ. of Minnesota, Minneapolis). Phys. Rev., C; 4: No. 2, 306–17(Aug 1971).

The features of the kernel function in the nonlocal n + α interaction, derived with the resonating-group method, which uses a totally antisymmetric wave function and a nucleon–nucleon potential, are studied. This kernel function is made up of three terms, corresponding to knock-out, heavy-particle-pickup, and nucleon-rearrangement processes. In the medium- and high-energy regions, the knockout process contributes mainly in the forward directions, while the heavy-particle-pickup and nucleon-rearrangement processes contribute mainly in the backward directions. In particular, it is found that these latter two processes are almost entirely responsible for the occurrence of large backward-angle cross sections in the n + α problem. An equivalent local potential between the neutron and the α particle is also constructed, which, in the Born approximation, yields the same results as does the resonating-group calculation. This equivalent local potential has an explicit energy dependence and a significant amount of Majorana space-exchange component. Finally, approximation methods are proposed which contain the essential features of the antisymmetrization procedure and yet can be used to consider such more complicated problems as the scattering of nucleons by medium- and heavy-weight nuclei. (auth)

50635 BINDING ENERGY OF THE ALPHA PARTICLE WITH A TENSOR VELOCITY-DEPENDENT POTENTIAL. Mahanti, D.; Yadav, K. L.; Srivastava, B. K. (Indian Inst. of Tech., Kharagpur). pp 231–4 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208–(Vol.1).

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50636 CONNECTION BETWEEN THE RMS CHARGE RADII AND Σ_b^{E1} FOR TRI-NUCLEONS. Mathur, V. S.; Lagu, A. V. (Banaras Hindu Univ., India). pp 244-7 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol. 2).

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 48989, 49036, 49610, 50046, 50219, 50619, 50679, 50723, 50724, 50771, 50772, 50818, 50846, 50847, and 51253.

50637 (UAE-NPL-1009) A DOUBLE-STRIPPING STUDY OF ^{16}O STRUCTURE. Honsaker, J. L.; Hsu, T. H.; McDonald, W. J.; Neilson, G. C. (Alberta Univ., Edmonton. Nuclear Research Centre). Jan 1970. 16p. Dep. NTIS (U. S. Sales Only).

Angular distributions of the reaction $^{14}C(^3He,n)^{16}O$ have been measured at 6 MeV for the lowest states in ^{16}O. The ground state distribution has been analyzed by double-stripping DWBA and the amplitudes of s-d shell transfer determined relative to $1p^2$ transfer. The results are smaller than the values predicted by shell model calculations. The next higher level showing a direct-reaction distribution appears to be the 1^- level at 7.12 MeV. The $6.05(0^+)$ and $6.92(2^+)$ levels do not show strong direct formation, in agreement with their supposedly predominant 4p-4h nature. Excitation functions from 3.5 to 6 MeV for these lowest levels have a resonance at 4.1 MeV as the only outstanding feature. (auth)

50638 COMPILATION OF GAMMA-TRANSITION ENERGIES OF RADIONUCLIDES PRODUCED BY REACTOR IRRADIATION. Dams, R.; Adams, F. (Ghent Univ.). J. Radioanal. Chem.; 7: No. 1, 127-60(Jan 1971).

A previously published compilation of γ-radiation energies for reactor-produced isotopes has been revised. Data are presented on 266 isotopes, which correspond to nearly all (n,γ) or (n, threshold) produced isotopes from elements of natural isotopic composition whose γ radiation is observable by γ spectrometry. (J.G.B.)

50639 STUDY OF THE $^{12}C(t,n)^{14}N$ REACTION AT 1.1 TO 1.7 MeV. Maluszynska, K. (Univ., Lodz, Poland); Przytula, M.; Sizov, I. V. Acta Phys. Pol.; B2: No. 2-3, 183-9(Apr-Jun 1971).

Angular distributions of three neutron-groups from the $^{12}C(t,n)^{14}N$ reactions were measured at 1.12, 1.26, 1.375, and 1.68 MeV by using the nuclear-emulsion method. A strong dependence of the shape of the angular distribution for the n_0 group on the triton energy was observed. The angular distributions of the n_1 group are very similar to those of the $^{12}C(t,p_0)$ reaction. A large maximum at backwards angles was found for the n_2 group at 1.68 MeV. (auth)

50640 MEASUREMENT OF THE LIFETIMES OF THE ^7Li LEVEL (477 keV) AND THE ^{12}C LEVEL (4,430 keV) FROM A REDUCTION OF THE DOPPLER BROADENING IN A Ge(Li) SPECTROMETER. Begzhanov, R. B.; Gladyshev, D. A.; Akilov, F. S.; Khalikov, A. Kh. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 1, 55-61 (1971). (In Russian).

A high-resolution Ge(Li) spectrometer was used to measure the lifetimes of ^7Li and ^{12}C levels at 477 and 4,430 keV, respectively. The detector had a sensitivity of 11 cm^3, and the deviation from linearity did not exceed 2%. The resolution of the spectrometer was about 7 to 10 KeV. The excited ^7Li (477 keV) level resulted from the $^{10}B(n,\alpha)^7Li$ reaction using thermal neutrons and possessed a lifetime of 96 ± 12 fsec. The excited $^{12}C(4,430$ keV) level resulted from the $^9Be(\alpha,n)^{12}C$ reaction, using a Po–Be source, and was characterized by a lifetime of 45 ± 10 fsec. (K.S.W.)

50641 (d,n) REACTION ON 1p SHELL NUCLEI AT E_d = 11.8 MeV. Mutchler, G. S.; Rendic, D.; Velkley, D. E.; Sweeney, W. E. Jr.; Phillips, G. C. (Rice Univ., Houston, Tex.). Nucl. Phys.; A172: No. 3, 469-88(1971).

The absolute differential cross sections have been measured for (d,n) reactions on $^{10,11}B$ and $^{12,13}C$ at an incident deuteron energy of 11.8 MeV. The measured angular distributions were compared with distorted-wave Born approximation (DWBA) calculations using average 1p shell parameters. These calculations successfully reproduce the general shape of the angular distributions, but fail to predict the magnitude of the cross sections at back angles. Absolute spectroscopic factors have been extracted and compared with theoretical predictions and previous experimental measurements. A definite J-dependence in the structure of the angular distributions is observed but is not reproduced by the DWBA calculations. The deduced spectroscopic factors are also compared with the results from (τ,d) reactions to look for a possible T-dependence. (auth)

50642 OFF-MASS-SHELL EFFECTS AND NUCLEAR STRUCTURE IN THE ^6Li(alpha,2alpha)d REACTION. Watson, J. W.; Pugh, H. G.; Roos, P. G.; (and others) (Univ. of Maryland, College Park). Nucl. Phys.; A172: No. 3, 513-54(1971).

The $^6Li(\alpha,2\alpha)d$ reaction was studied at 50.4, 59.0, 60.5, 70.3 and 79.6 MeV bombarding energy. For each bombarding energy, several coincident energy spectra of the two emitted α-particles were measured. Special emphasis was placed on measuring spectra at pairs of angles where zero laboratory momentum was possible for the residual deuteron. The spectra were analyzed with the plane wave impulse approximation. From those points in the spectra which corresponded to zero deuteron momentum, off-mass-shell $\alpha-\alpha$ cross sections were extracted. These were found to be in excellent agreement with free $\alpha-\alpha$ cross sections, if free cross sections for the final state $\alpha-\alpha$ c.m. energy were chosen for the comparison. Off-mass-shell $\alpha-\alpha$ cross sections were also extracted for data where the residual deuteron had a momentum of 30 MeV/c. These cross sections were also found to agree with free $\alpha-\alpha$ scattering, but it was necessary to introduce an ad hoc shift in the $\alpha-\alpha$ scattering angle to produce this agreement. Predictions of off-mass-shell $\alpha-\alpha$ cross sections were made using a potential model. These indicate that the off-mass-shell cross section should indeed be very similar to the on-mass-shell cross section at the final state energy. Using the plane wave impulse approximation a momentum distribution for α-particles in ^6Li was extracted from the experimental data. A cluster model for ^6Li was devised to fit the binding energy and rms charge radius of ^6Li, as well as the $^3S_1$ $\alpha-d$ scattering phase shifts. For comparison with the experimental data, the momentum wave function of the $\alpha-$particle in ^6Li was calculated by taking the Fourier transform of the $\alpha-d$ relative motion. The theoretical and experimental momentum distributions were found to be in serious disagreement, both in magnitude and width at half maximum. By introducing a cut-off radius into the theoretical wave function, the discrepancies between theory and experiment were accounted for. It was also found that if the cut-off radius is used as an adjustable parameter, then this ^6Li wave function and reaction model explains the magnitudes and widths of the $\alpha-d$ relative momentum distributions determined from a wide variety of other reactions. (auth)

50643 STATES IN ^8Be STUDIED THROUGH THE REACTION $^{11}B(p,\alpha)^8Be$ WITH 40 MeV PROTONS. Kamke, D. G.; Goodman, C. D. (Oak Ridge National Lab., Tenn.). Nucl. Phys.; A172: No. 3, 555-68(1971).

Spectroscopy of the α and ^3He particles from 40-MeV proton bombardment of ^{11}B reveals transitions to ^8Be states up to 19 MeV. The ratio of excitation of the 16.6 MeV state to the 16.9 MeV state is 2.3 ± 0.4. The $^8Be(4^+)$ state is found at 12.5 MeV with a width of 4.0 ± 0.5 MeV. States in ^9Be excited most strongly are the g.s. and 2.43 MeV level; a state at 3.1 MeV is excited with about 1% of the strength of the g.s. transition. Angular distributions show forward-peaking for all states. (auth)

50644 STUDY OF ^{15}O STATES BY THE $^{14}N(d,n)$ REACTION. Bommer, J.; Fuchs, H.; Grabisch, K.; Janetzki, U.; Roeschert, G. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nucl. Phys.; A172: No. 3, 618-24(1971).

The reaction $^{14}N(d,n)^{15}O$ has been investigated at 5.6 and 6.0 MeV bombarding energy by means of the neutron time-of-flight method. Angular distributions for nine final states have been extracted and analyzed with DWBA and Hauser–Feshbach calculations to yield spectroscopic factors. These are compared to results of previous experiments and of shell-model calculations. The $p^{-2}d_{\frac{5}{2}}$ configuration is strongly mixed with the states of the $p^{-2}(d_{\frac{3}{2}}, s_{\frac{1}{2}})$ configurations; its inclusion therefore is necessary for a correct description of low-lying even-parity states of ^{15}O. (auth)

50645 FINAL-STATE INTERACTIONS IN THE $^6Li(d,^6Lip)n$ REACTION. Von Witsch, W.; Ivanovich, M.; Otte, V. A.; Rendic, D.; Phillips, G. C. (Rice Univ., Houston, Tex.). Nucl. Phys.; A172: No. 3, 633-42(1971).

The $^6Li(d,^6Li,p)n$ reaction has been investigated in a kinematically complete experiment at 10 MeV bombarding energy and at three pairs of angles. The spectra show pronounced ^6Li–n final-state interactions in the 9.7 MeV state and, especially in the 7.48 MeV state of ^7Li, in qualitative agreement with the known decay properties of these levels. At one angle, a possible

indication of some contribution from the (isospin forbidden) $^1S_0$ proton-neutron final-state interaction has been observed. (auth)

50646 WHY IS THERE NO ROTATIONAL BAND BASED ON THE 7.65 MeV 0^+ STATE IN ^{12}C. Friedrich, H.; Satpathy, L.; Weiguny, A. (Univ., Muenster, Ger.). Phys. Lett.; 36B: No. 3, 189-92(6 Sep 1971).

Mixing a discrete number of α-particle configurations shows that the intrinsic structure of the second 0^+ state in ^{12}C is well described by three α-particles almost in a straight line. The absence of a rotational band based on this strongly deformed structure is explained by the instability of higher I-states against break-up into $^8Be + \alpha$. (auth)

50647 COULOMB EFFECTS IN THE A = 13, 18 MIRROR β-DECAYS AND THE SECOND CLASS CURRENT PROBLEM. Blin-Stoyle, R. J.; Evans, J. A.; Khan, A. M. (Univ. of Sussex, Falmer, Eng.). Phys. Lett.; 36B: No. 3, 202-4(6 Sep 1971).

The effect of the Coulomb potential on the proportional difference in ft-values, δ_c for the A = 13 and A = 18 mirror β-decays is calculated and found to be $\delta_c^{(13)} \approx 0.1\%$ and $\delta_c^{(18)} \approx -4.1\%$. The results do not modify previous interpretations of these differences in terms of second class currents. (auth)

50648 REACTIONS $^{16}O(d,p)^{17}O$ AND $^{28}Si(d,p)^{29}Si$ INITIATED BY VECTOR-POLARIZED DEUTERONS. Kocher, D. C.; Bjorkholm, P. J.; Haeberli, W. (Univ. of Wisconsin, Madison). Nucl. Phys.; Aa72: No. 3, 663-72(1971).

The vector analyzing power has been measured for the reactions $^{16}O(d,d)^{16}O$ and $^{16}O(d,p)^{17}O$ leading to states in ^{17}O at $E_x = 0.0$ and 0.87 MeV at a deuteron energy of 8 MeV. The vector analyzing power and the cross section for the $^{28}Si(d,p)^{29}Si$ reaction leading to states in ^{29}Si at $E_x = 0.0$, 1.27, 2.03, 2.43, 3.07, 3.62, and 4.08 MeV have been measured at a deuteron energy of 9 MeV. For $l_n = 2$ transitions, the vector analyzing power near the stripping peak is found to be negative for $j^\pi = 3/2^+$ and positive for $j^\pi = 5/2^+$. The measurements on $^{16}O(d,d)^{16}O$ were analyzed in terms of the optical model. The (d,p) measurements are compared with DWBA calculations. Spectroscopic factors obtained from the analysis are in fair agreement with theoretical predictions. (auth)

50649 NON-NORMAL PARITY STATES IN A = 14 AND 13 NUCLEI. I. LOW-LYING STATES. Jaeger, H. U. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.); Kissener, H. R.; Eramzhyan, R. A. Nucl. Phys.; A171: No. 1, 16-30(1971).

Shell-model calculations taking into account all 1 $\hbar\omega$ configurations were performed for the A = 13 and 14 systems. The spurious states due to the c.m. motion were removed exactly. The level schemes, complete sets of single-particle spectroscopic amplitudes, and electromagnetic transition rates were calculated. These quantities are compared with the available data and the results of other calculations. A good description of the nonnormal parity states below 10 MeV is obtained throughout: the deviations of the excitation energies (17 levels) are less than 0.7 MeV. Most of the states in this energy region have a simple parent structure, and their main properties can be explained also in a more restricted configuration space. For the higher-lying levels the model provides the first results that are consistent with the reported experiments. (auth)

50650 ANALYSIS OF THE ^{14}C β-DECAY SPECTRUM. Huffaker, J. N. (Univ. of Oklahoma, Norman). Nucl. Phys.; A171: No. 1, 87-91(1971).

The β-decay correction factor for ^{14}C decay is calculated by using "exact" electron radial functions and including higher-order effects. Results are presented for a number of nuclear models of the mass-14 system and for the general class of such models agreeing with the ^{14}C ft value. The calculated correction factors are in disagreement with recent measurements. (auth)

50651 EVIDENCE FOR OBLATE SHAPE OF ^{12}C FROM INELASTIC α-PARTICLE SCATTERING. Specht, J. (Kernforschungszentrum, Karlsruhe, Ger.); Schweimer, G. W.; Rebel, H.; (and others). Nucl. Phys.; A171: No. 1, 65-72(1971).

The differential cross sections for the scattering of 104-MeV α particles from the ground and first excited states of ^{12}C were measured in the angular range of 5 to 176°. The differential cross sections were analyzed with the theory of Austern and Blair, the rotational model was assumed, and multiple excitations for both the elastic and inelastic scattering were taken into account. This technique proves to be sensitive to the sign of the quadrupole deformation. A negative sign leads to the best fit of the data. A hexadecapole deformation could not be detected. Electric multipole moments and deformation parameters were deduced by taking into account electron scattering results. These values are compared with Hartree–Fock calculations. (auth)

50652 REGGE TRAJECTORIES FOR LIGHT NUCLEAR SYSTEMS. Sen, Dilip; Shastry, C. S. (Louisiana State Univ., Baton Rouge). Phys. Rev., C; 4: No. 2, 349-54(Aug 1971).

A large number of nuclear levels in the light nuclei ^{16}O, ^{20}Ne, ^{17}O, ^{17}F, ^{13}C, and ^{13}N are classified in terms of the Regge trajectories in the channels $(^{12}C,\alpha)$, $(^{16}O,\alpha)$, $(^{16}O,n)$, $(^{16}O,p)$, $(^{12}C,n)$, and $(^{12}C,p)$, respectively. The mirror nuclei $(^{17}O,^{17}F)$ and $(^{13}C,^{13}N)$ have isobaric analog trajectories. The Regge trajectories obtained by coupling a nucleon with the first excited state of an ^{16}O or a ^{12}C nucleus are also constructed from the levels of ^{17}O (or ^{17}F) and ^{13}C (or ^{13}N), respectively. (^{16}O, nucleon) and (^{12}C, nucleon) are spin-zero–spin-$1/2$ systems and contain trajectories corresponding to both $J = l - 1/2$ and $J = l + 1/2$ couplings. (auth)

50653 MODIFIED FADDEEV EQUATIONS FOR THREE BOUND α PARTICLES IN ^{12}C. Osman, Ahmed (Cairo Univ.). Phys. Rev., C; 4: No. 2, 302-6(Aug 1971).

The bound state of three α particles is considered. The Coulomb Green's function in the nucleus ^{12}C is considered for the α-cluster model. The calculated binding energy of the ^{12}C nucleus is consistent with previous calculations. (auth)

50654 POLARIZATION MEASUREMENTS OF THE GAMMA-RAY TRANSITIONS FROM THE 1.459-MeV LEVEL IN ^{19}F. Hardy, K. A.; Lumpkin, A. H.; Lee, Y. K.; Owen, G. E. (Johns Hopkins Univ., Baltimore). Phys. Rev., C; 4: No. 2, 317-21 (Aug 1971).

Linear-polarization and angular-distribution measurements were made on the three transitions from the 1.459-MeV level in ^{19}F by using inelastic proton scattering. The mixing ratios were determined to be $-0.1 < \delta_{M2/E1} < 0.0$ for the 1.459 → 0.197-MeV transition, $0.30 < \delta_{E2/M1} < 0.38$ for the 1.459 → 0.110-MeV transition and $|\delta_{M2/E1}| < 0.06$ for the 1.459 → 0-MeV transition. The results indicate that the level in question cannot be explained as a $p_{\frac{1}{2}}$ proton hole coupled to the pure ground-state rotational band as has been accepted in the past. (auth)

50655 SINGLET DEUTERON p–n CORRELATIONS IN THE $^{13}C(p,pn)^{12}C$ REACTION. Otte, V. A.; von Witsch, W.; Sandler, J.; Rendic, D.; Phillips, G. C. (Rice Univ., Houston, Tex.). Phys. Rev., C; 4: No. 2, 322-7(Aug 1971).

The three-body reaction $^{13}C(p,pn)^{12}C$ was studied experimentally in a kinematically complete experiment. p–n coincidence events were measured for several bombarding energies between 7.9 and 12.5 MeV by using associated time-of-flight techniques, pulse-shape discrimination for the neutron-detection system, and a silicon surface-barrier detector for the charged particles. Only in the region of 12.5 MeV bombarding energy is there an indication of sequential decay via "singlet deuteron" formation. Higher energies were not attainable with the available equipment, and at lower energies sequential decay through levels in ^{13}C and ^{13}N was relatively strong and obstructed the observation of possible contributions from p–n final-state interactions. An upper limit is assigned to the two-body (p,d*) cross section. (auth)

50656 RADIATIVE DECAY OF THE 1.472-MeV STATE OF ^{19}O. McDonald, R. E. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.); Becker, J. A.; Jones, A. D. W.; Poletti, A. R. Phys. Rev., C; 4: No. 2, 377-80(Aug 1971).

The mean lifetime of the 1.472-MeV level ($J^\pi = 1/2^+$) in ^{19}O was measured using the Doppler-shift-attenuation method and found to be $\tau_m = 1.22 \pm 0.36$ psec. The level decays $(1.4 \pm 0.2)\%$ to the ground state ($J^\pi = 5/2^+$) and $(98.6 \pm 0.2)\%$ to the state at 96 keV ($J^\pi = 3/2^+$). Energies of the first and second excited states of ^{19}O were measured as 96.0 ± 0.5 and 1472 ± 1 keV, respectively. The experimental results are compared with a theoretical calculation. (auth)

50657 ^{11}B STATES OBSERVED IN THE SCATTERING OF NEUTRONS FROM ^{10}B AND IN THE $^{10}B(n,\alpha)^7Li$ REACTION. Lane, R. O. (Ohio Univ., Athens); Hausladen, S. L.; Mohahan, J. E.; (and others). Phys. Rev., C; 4: No. 2, 380-90(Aug 1971).

The polarization and the differential scattering cross sections for neutrons scattered from ^{10}B were measured for $0.075 \le E_n \le 2.2$ MeV. These results, together with those from the $^{10}B(n,\alpha_0)^7Li$, $^{10}B(n,\alpha_1)^7Li^*(0.48\ MeV)$, $^7Li(\alpha,\alpha)^7Li$, $^7Li(\alpha,\alpha')^7Li^*(0.48\ MeV)$, and other reactions leading to states in ^{11}B, were simultaneously interpreted in one consistent R-matrix calculation. The calculated results are in good agreement with most of the data, and give new information about states in ^{11}B. The level parameters obtained for these states and the calculated reaction cross sections are consistent with the corresponding quantities in the mirror nucleus ^{11}C. Quantitative explanations are given both for the well-known 1/v behavior of the cross section for the $^{10}B(n,\alpha)^7Li$ reaction and for the α_0/α_1 branching ratio. (auth)

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50658 ANGULAR CORRELATION ANALYSIS OF THE (π,n) REACTION. Jain, B. K. (Bhabha Atomic Research Centre, Trombay, India); Banerjee, B. pp 35–40 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208–(Vol. 2).

50659 DISTORTION AND ANTISYMMETRISATION EFFECTS IN ^{6}Li(p,pd)^{4}He REACTION. Jain, A. K.; Sarma, N. (Bhabha Atomic Research Centre, Trombay, India). pp 51–4 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208–(Vol.2).

50660 DETERMINATION OF WIDTH AND RESONANCE ENERGY OF THE 7.01 MeV LEVEL IN ^{10}B AND COMPARISON OF THE EXPERIMENTALLY OBSERVED SPIN WITH INTERMEDIATE COUPLING CALCULATIONS. Balakrishnan, M.; Mehta, M. K.; Divatia, A. S. (Bhabha Atomic Research Centre, Trombay, India). pp 55–9 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208–(Vol.2).

50661 MEASURED (n,p) REACTION CROSS SECTIONS AND THEIR PREDICTED VALUES AT 14.8 MeV. Prasad, R.; Sarkar, D. C. (Aligarh Muslim Univ., India). pp 112–16 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208–(Vol.2).

50662 ABSOLUTE (n,2n) CROSS SECTIONS OF NUCLEI NEAR 14 MeV. Chatterjee, Arun; Nath, A.; Ghose, A. M. (Bose Inst., Calcutta). pp 117–21 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208–(Vol.2).

50663 RELATIVISTIC CORRECTION TO NUCLEAR SPECTRA. Khadkikar, S. B. (Tata Inst. of Fundamental Research, Bombay). pp 242–3 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208–(Vol.2).

50664 CHARGE FORM FACTOR FOR ^{6}Li NUCLEUS. Jain, A. K.; Sarma, N. (Bhabha Atomic Research Centre, Bombay). pp 345–8 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208–(Vol.2).

50665 RESONATING MAGIC CORES MODEL FOR ^{10}B NUCLEUS. Narayana, K. L. (Shivaji Univ., Kolhapur, India). pp 356–7 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208–(Vol.2).

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Refer also to abstracts 48983, 49962, 50051, 50149, 50219, 50271, 50578, 50638, 50648, 50652, 50661, 50723, 50724, 50768, 50770–50772, and 50876.

50666 (UAE-NPL–1024) ELECTROMAGNETIC PROPERTIES OF ^{45}Ti EXCITED STATES. Iyengar, K. V. K.; Robertson, B. C. (Alberta Univ., Edmonton. Nuclear Research Centre). [1971]. 25p. Dep. NTIS (U. S. Sales Only).

The lifetimes of several levels in ^{45}Ti were measured via the reaction ^{45}Sc(p,nγ)^{45}Ti using the Doppler Shift Attenuation Method. The presence of levels at 1.958, 2.260, and 2.432 MeV excitation observed by a neutron time-of-flight technique are reported. Spins of $^{9}/_{2}^{-}$ and $^{11}/_{2}^{-}$ are assigned to the levels at 1.354 and 1.468 MeV, respectively, from angular distribution measurements of their γ-decay modes and from the lifetime determinations. (auth)

50667 (UCRL–51060) STUDY OF GAMMA RAYS FOLLOWING THERMAL NEUTRON CAPTURE IN ^{42}Ca AND ^{44}Ca. Birkett, Ray Edward (California Univ., Livermore. Lawrence Radiation Lab.). May 1971. Contract W-7405-eng-48. 250p. Dep. NTIS. Thesis.

Gamma radiation following thermal neutron capture by ^{42}Ca and ^{44}Ca has been measured at the Livermore Pool Type Reactor. Two spectrometer systems were used for collecting singles data, one a Ge(Li)–NaI(Tl) anticoincidence Compton suppression spectrometer, optimized for detecting γ rays in the region 0.06 to 3.0 MeV, and the other a NaI(Tl)–Ge(Li)–NaI(Tl) coincidence pair spectrometer, optimized for detecting γ rays in the range 2 to 8 MeV. For γ–γ coincidence measurements the Ge(Li) detectors were operated together as part of a three-parameter coincidence analyzer (E_1, E_2, Δt). A total of 62 γ rays were assigned to 19 inferred excited levels in the ^{43}Ca level scheme. The placement of 44 of these γ-rays was confirmed by the coincidence analysis. In ^{45}Ca the positions of 13 excited levels were established according to the placement of 35 γ-rays, 26 of which were confirmed by the coincidence data. A strong positive correlation was found between the (d,p) l = 1 transfer strengths (2J + 1)S and the (n, γ) primary γ-ray transition strengths $I_\gamma E_\gamma^3$ leading to the same final states; for ^{43}Ca the correlation coefficient is 0.92 and for ^{45}Ca it is 0.91. In ^{43}Ca the γ-ray branching ratios measured for high lying l_n = 1 levels lead to tentative spin assignments of $^{1}/_{2}^{-}$ for the levels at 2611, 2878, 4207, 4901 and 5038 keV, and $^{3}/_{2}^{-}$ for the levels at 2943, 3286 and 3573 keV. The neutron binding energy of ^{43}Ca is 7933.1 ± 0.4 keV, and of ^{45}Ca is 7415.1 ± 0.5 keV. The recent (n, γ) work of two other groups is in good over-all agreement with this work. (auth)

50668 EFFECTIVE INTERACTION OF VALENCE NEUTRONS IN ^{58}Ni. Bochnacki, Z. (Inst. of Nuclear Physics, Krakow); Mikhailov, I. N.; Rybarska, W. Acta Phys. Pol.; B2: No. 2-3, 365-70(Apr-Jun 1971).

In the case of ^{58}Ni the matrix elements of the effective interaction of the last two nucleons are calculated using Migdal's method and compared with those given by Kuo [Nucl. Phys., A90: 199(1967)] and empirical values determined by Auerbach [Nucl. Phys., 76: 321(1966)]. (auth)

50669 DECAY OF ^{73m}Se. Voinova, N. A.; Gonsior, M.; Lizurei, H. I.; Potempa, A. V. (Inst. of Nuclear Physics, Krakov. Ioffe Inst. of Physics and Tech., Leningrad). Acta Phys. Pol.; B2: No. 2-3, 265-75(Apr-Jun 1971). (In Russian).

The levels in ^{73}As populated by the decay of 41-min ^{73m}Se were investigated. The conversion-electron spectra in the energy region 20 to 1200 keV and gamma spectra were measured. The conversion coefficients and multipolarities of 12 transitions were determined. The level structure of ^{73}As obtained is compared with data of the adjacent As isotopes and with recent theoretical calculations. (auth)

50670 LOW-ENERGY EXCITED STATES OF ^{76}As FROM THE ^{76}Ge(p,n)^{76}As REACTION. Balanda, A.; Kopta, S.; Lizurej, H. I.; Meczynski, W. (Jagellonian Univ., Krakow). Acta Phys. Pol.; B2: No. 2-3, 277-83(Apr-Jun 1971).

Spectra of gamma radiation and internal conversion electrons from several germanium targets bombarded with 2.9-MeV protons were measured. Eleven transitions between ^{76}As states excited in the ^{76}Ge(p,n)^{76}As reaction were identified. The energies of these states were found to be 45.5, 87, 121, 166, 265, 302, 377, 515, and 550 keV. The possible values of spin of the 87- and 121-keV levels are confined to 1^+, 2^+, and 3^+. (auth)

50671 SPECTROSCOPY OF ^{54}Mn. Gastebois, J.; Kuzminski, J.; Laget, J. M. (Centre d'Etudes Nucleaires, Saclay, France). Acta Phys. Pol.; B2: No. 2-3, 293-305(Apr-Jun 1971).

The experimental results of the ^{52}Cr(^{3}He,p)^{54}Mn and ^{53}Cr(^{3}He,d)^{54}Mn reactions, performed at E(^{3}He) = 18 MeV, and the results of the ^{56}Fe(d,α)^{54}Mn reaction, performed at E(d) = 12 MeV, are presented. The experimental data are analyzed in the framework of the DWBA theory. The main conclusion of this study is that the configuration mixing is important, even in the ^{54}Mn low-lying-state wave functions. (auth)

50672 PHOTONEUTRON CROSS SECTIONS FOR ^{24}Mg, ^{26}Mg, AND NATURAL MAGNESIUM. Fultz, S. C. (Univ. of California, Livermore); Alvarez, R. A.; Berman, B. L.; (and others). Phys. Rev., C; 4: No. 1, 149-65(Jul 1971).

Photoneutron cross sections for ^{24}Mg, ^{26}Mg, and natural mag-

nesium were measured with the use of monochromatic photons obtained from the annihilation in flight of fast positrons. The resolution was less than 200 keV at 10-MeV photon energy, and 300 keV at 30 MeV. About 14 resonant structures in ^{24}Mg and 32 in ^{26}Mg were distinguished and parametrized. A Porter–Thomas treatment of the distributions of transition widths throughout the giant resonances of ^{24}Mg and ^{26}Mg indicates that the resonances belong to single-spin states, or have one degree of freedom in each case. The ^{26}Mg(γ,2n) cross section contains considerable structure, most of it coinciding with the structure in the total photoneutron cross section. It is confirmed that the giant resonance of ^{26}Mg is split into two isospin components. Integrated total cross sections up to 28 MeV are 50 MeV mb for ^{24}Mg, 226 MeV mb for ^{26}Mg, and 76 MeV mb for natural magnesium. (auth)

50673 LIFETIME OF THE 78-keV LEVEL OF ^{32}P. Gordon, D. M.; Kavanagh, R. W. (California Inst. of Tech., Pasadena). Phys. Rev., C; 4: No. 1, 145-8(Jul 1971).

A mechanical-recoil method was used to measure the lifetime of the 78-keV first excited state of ^{32}P. This state was populated near threshold by the ^{29}Si(^{4}He,p)^{32}P reaction, using an enriched $^{29}SiO_2$ target on the down-beam side of a thin copper backing, so that the ^{32}P nuclei recoiled into vacuum. The 78-keV γ rays were detected, after passing the edge of a movable absorber, by a narrow rectangular Ge(Li) detector (2 × 2 × 20 mm). From the exponential curve of count rate vs absorber displacement, a value of $\tau = 402 \pm 13$ psec is found for this level. A similar measurement, using the ^{19}F(^{3}He,n)^{22}Na reaction, gave an upper limit of $\tau \leq 26 \pm 6$ psec for the 74-keV M1 transition from the 657-keV excited state of ^{22}Na.

50674 STUDIES OF ^{89}Nb DECAY. Arl't, R.; Zaitseva, N. G.; Kratsik, B.; (and others). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 1, 27-34(Jan 1971). (In Russian).

Data are presented on the ^{89}Nb γ spectrum measured with a Ge(Li) spectrometer with high energy resolving power. A decay scheme for ^{89}Nb was developed. (R.V.J.)

50675 MEASUREMENTS OF THE ^{66}Zn(α,α$_1$γ)^{66}Zn ANGULAR CORRELATION. Bucurescu, D. (Inst. of Atomic Physics, Bucharest); Dumitrescu, R.; Ivascu, M.; (and others). Rev. Roum. Phys.; 16: No. 5, 511-14(1971).

The $\alpha'-\gamma$ angular correlation in the reaction ^{66}Zn(α,α$_1$γ)^{66}Zn has been studied at the bombarding energy $E_\alpha = 19.5$ MeV. The experimental correlation parameters are compared with predictions of the DWBA and Austern-Blair theory. Nonadiabatic effects are found to be important, but for a better agreement with the experimental data the Coulomb excitation must be included in calculations too. (auth)

50676 LIFETIMES OF EXCITED STATES OF ^{27}Si. Weaver, J. J.; Hutcheon, D. A.; Start, D. F. H.; Zurmuehle, R. W.; Grace, M. A. (Oxford Univ.). Nucl. Phys.; A172: No. 3, 577-88(1971).

The mean lifetimes of the first six excited states of ^{27}Si were measured using the reaction ^{27}Al(p,nγ)^{27}Si. The Doppler-shift attenuation method was used in a nγ coincidence arrangement. The results are: 0.78 MeV, >8.8 ps; 0.96 MeV, 1.76 ± 0.20 ps; 2.16 MeV, 53 ± 9 fs; 2.65 MeV, 37 ± 16 fs; 2.87 MeV, <15 fs; 2.91 MeV, 75 ± 14 fs. Accurate excitation energies have been obtained for ^{27}Si states. Levels at 2.87 MeV and 2.91 MeV have been given tentative spin assignments of $3/2^+$ and $9/2^+$ respectively. The deduced E2 and M1 transition rates are compared to different collective model predictions and also to the experimentally obtained B(E2) and B(M1) values of corresponding transitions in the mirror nucleus ^{27}Al. (auth)

50677 TRANSITIONS BETWEEN ANALOG STATES OF ^{55}Fe. Leslie, J. R.; Martin, D. J.; McLatchie, W. (Queen's Univ., Kingston, Ont.). Phys. Lett.; 36B: No. 2, 76-8(23 Aug 1971).

Gamma-ray transitions have been observed between states in ^{55}Co which are identified as analogs of states of ^{55}Fe. A comparison of the transition probabilities shows that the states in ^{55}Co have mixed isospin. (auth)

50678 M2 RADIATIVE WIDTHS OF NUCLEAR LEVELS AT ABOUT 7 MeV EXCITATION. Moreh, R.; Nof, A.; Shahal, O.; Wolf, A. (Nuclear Research Centre, Negev, Israel). Phys. Lett.; 36B: No. 2, 71-3(23 Aug 1971).

The M2 widths and M2/E1 mixing ratios in transitions of the form $1^- \rightarrow 2^+$ from nuclear levels at about 7 MeV excitation in ^{74}Ge, ^{100}Mo, ^{112}Cd, and ^{186}W have been measured. The M2 widths are found to be about the same average magnitude as the M2 widths in nuclei with A < 40. (auth)

50679 TOTAL YIELD MEASUREMENTS IN ^{16}O(α,γ)^{20}Ne AND ^{28}Si(α,γ)^{32}S. Toevs, James W. (California Inst. of Tech., Pasadena). Nucl. Phys.; A172: No. 3, 589-602(1971).

The ^{28}Si(α,γ)^{32}S and ^{16}O(α,γ)^{20}Ne reactions have been investigated to provide data for the calculation of the stellar rates of these reactions. The γ-rays were counted with a NaI(Tl) detection system having a high detection efficiency which is approximately independent of the γ-ray cascade structure of a resonance level; the detection efficiency was determined experimentally. The reaction ^{28}Si(α,γ)^{32}S was studied for He^+ bombarding energies from 1.4 to 2.7 MeV; in this region, five new resonances were found, and their strengths, $(2J + 1)\Gamma_\alpha\Gamma_\gamma/\Gamma$, were measured. An upper limit for the cross section was established for bombarding energies below 1.7 MeV. The ^{16}O(α,γ)^{20}Ne reaction was investigated in the energy region from 0.85 to 1.8 MeV; strengths for the previously known resonances were measured, and an upper limit for the cross section was determined for energies below 1 MeV. The influence of these results on the stellar reaction rates is discussed. (auth)

50680 $K^\pi = 1/2^-$, [330] ROTATIONAL BAND IN A = 21 TO 27 NUCLIDES. Roepke, H.; Glattes, V.; Hammel, G. (Univ., Freiburg, i. B.) Nucl. Phys.; A172: No. 3, 506-12(1971).

The experimental material on levels in A = 21–27 nuclides which are prospective members of the $K^\pi = 1/2^-$, [330] rotational band, is surveyed. The levels in ^{21}Na, ^{21}Ne, ^{23}Ne, ^{25}Al, ^{25}Mg, ^{27}Al and ^{27}Mg show a similar behavior with respect to excitation energies, γ-decay, reduced widths or spectroscopic factors. Only the $E_x = 3757$ keV, $J^\pi = 7/2^-$ level in ^{27}Mg has an anomalous γ decay. (auth)

50681 INVESTIGATION OF THE 6477 keV STATE IN ^{27}Al WITH A Ge(Li) γ-RAY POLARIMETER. Roepke, H.; Grawe, H.; Hammel, G. (Univ., Freiburg i. B.). Nucl. Phys.; A172: No. 3, 499-505(1971).

The $E_x = 6477$ keV level in ^{27}Al was populated at the $E_p = 2293$ keV, $J^\pi = 7/2^-$, $T = 3/2$ resonance in the ^{26}Mg(p,γ) reaction. The angular distribution and polarization of the R → 6477 keV γ-ray transition yield a unique spin-parity assignment $J^\pi(6477) = 7/2^-$. The lifetime of the $E_x = 6477$ keV level was measured, using the Doppler-shift attenuation method, as $\tau = 21 \pm 6$ fs. (auth)

50682 RESONANCE FLUORESCENCE STUDIES OF LEVELS IN ^{59}Co. Swann, C. P. (Franklin Inst., Swarthmore, Pa.). Nucl. Phys.; A172: No. 3, 569-76(1971).

A bremsstrahlung beam produced by electrons from a Van de Graaff accelerator has been used to excite fifteen levels in ^{59}Co up to about 4.5 MeV. The first five of these have energies (keV), spins and parities, and ground state transition widths (meV) of (the assumed branching ratios are given in brackets) 1099, $3/2^-$, (1) 0.21 ± 0.04; 1190, $9/2^-$, (1) 8.2 ± 0.4; 1459, $11/2^-$, (1) 0.39 ± 0.04; 1480, $5/2^{+,-}$, (0.8) 1.68 ± 0.17; and 1475, $1/2^-$, (0.59) 0.66 ± 0.19. Using known mixing ratios, B(E2↓) values for these five levels are also given in comparison with the B(E2↓) for the 1332 keV 2^+ state of ^{60}Ni. Since the spins are not known, only cross sections are given for the higher energy levels. (auth)

50683 COMPARISON BETWEEN THE (^{3}He,^{7}Be) α-PICKUP REACTIONS ON ^{40}Ca AND ^{40}Ar. Zafiratos, C. D.; Detraz, C.; Moss, C. E.; Zaidins, C. S. (Univ. of Colorado, Boulder). Phys. Rev. Lett.; 27: No. 7, 437-9(16 Aug 1971).

There have been recent suggestions, based on backward-angle anomalies of elastic α-particle scattering, that ^{40}Ca and ^{40}Ar have strikingly different α-clustering probabilities. Since a convincing body of evidence exists for the α-pickup character of the (^{3}He, ^{7}Be) reaction, the reactions ^{40}Ca(^{3}He,^{7}Be)^{36}Ar and ^{40}Ar (^{3}He,^{7}Be)^{36}S were investigated at an incident energy of 41 MeV. No substantial difference was found between the ground-state transitions. (auth)

50684 VECTOR ANALYZING POWER AND CROSS SECTION FOR ^{40}Ca(d,p)^{41}Ca FROM 5 TO 11 MeV. Kocher, D.C.; Haeberli, W. (Univ. of Wisconsin, Madison). Nucl. Phys.; A172: No. 3, 652-62(1971).

Measurements of the vector analyzing power and cross section for the ^{40}Ca(d,p)^{41}Ca reaction leading to strongly populated states in ^{41}Ca ($E_x = 0.0$, 1.95, 2.47 and 3.95 MeV) have been made for deuteron energies of 5, 9, and 11 MeV. The vector analyzing power shows a pronounced j-dependence at all energies. The results were compared with DWBA calculations. The proton and deuteron optical model potentials were obtained from analyses of elastic cross sections and polarizations. The predicted vector analyzing power and cross-section angular distributions are in qualitative agreement with the measurements. Spectroscopic factors are compared with theoretical predictions. (auth)

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50685 CORRELATIONS BETWEEN PARTICLE RADIATIVE WIDTHS IN NEUTRON RESONANCES. Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett.; 36B: No. 3, 199-201(6 Sep 1971).

The cases in which there may exist significant correlations between reduced neutron widths for transitions from neutron resonances to definite final states are considered. Some suggestions on the determination of the degree of K-forbiddenness for E1 and M1 transitions from neutron resonances to low-lying states are given. It is indicated which nuclei are the most favorable, for studying experimentally, correlations between radiative widths and for determining the degree of K-forbiddenness. (auth)

50686 LOCATION OF THE MISSING 0^+, T = 1 STATE IN ^{26}Al. Fortune, H. T.; Betts, R. R.; Neogy, P.; Pullen, D. J. (Univ. of Pennsylvania, Philadelphia). Phys. Lett.; 36B: No. 3, 215-17 (6 Sep 1971).

In the ^{24}Mg(τ,p)^{26}Al reaction at a bombarding energy of 19.5 MeV, the state at E_X = 3.72 MeV is seen to be populated by an L = 0 transition and with the strength expected for a 0^+, T = 1 state of the pure $(K = 1/2^+)^2$ configuration. This result, together with previous information on ^{26}Al, makes compelling the identification of this state as the "missing" 0^+, T = 1 analog to the 3.58 MeV state in ^{26}Mg and the 3.32 MeV state in ^{26}Si. (auth)

50687 SEMI-REALISTIC SHELL MODEL STUDIES IN THE LEAD REGION. I. ^{211}Pb, ^{209}Tl, ^{209}Po. Baldridge, W.; Freed, N.; Gibbons, J. (Pennsylvania State Univ., University Park). Phys. Lett.; 36B: No. 3, 179-84(6 Sep 1971).

The semi-realistic approach developed earlier is applied to shell model calculations of ^{211}Pb, ^{209}Tl and ^{209}Po, all of which are describable as an odd particle or hole coupled to a ^{210}Pb or ^{210}Po core. Comparison with experiment is made for energy levels, spectroscopic factors and selected transition rates. Characteristic features of weak coupling are found to persist when the ^{208}Pb core is replaced by ^{210}Pb or ^{210}Po. (auth)

50688 PROTON ELASTIC SCATTERING FROM ^{63}Cu AND ^{65}Cu AT 30 AND 50 MeV. I. DIFFERENTIAL CROSS-SECTION AND POLARISATION MEASUREMENTS. Thomas, G. L.; Burge, E. J.; Smith, D. A. (King's Coll., London). Nucl. Phys.; A171: No. 1, 165-76(1971).

Differential cross-section and polarization measurements are reported for 30- and 50-MeV protons elastically scattered from the copper isotopes ^{63,65}Cu. The differential cross section measurements were made over the angular range 10 to 150° (lab) to an absolute accuracy of 1.5 to 4%, and the polarization measurements [10 to 148° (lab)] are accurate to 0.5 to 7%. (auth)

50689 PROTON ELASTIC SCATTERING FROM ^{63}Cu AND ^{65}Cu AT 30 AND 50 MeV. II. OPTICAL MODEL ANALYSIS. Thomas, G. L. (King's Coll., London). Nucl. Phys.; A171: No. 1, 177-98(1971).

Differential cross-section and polarization measurements for 30- and 50-MeV protons elastically scattered from the isotopes ^{63}Cu and ^{65}Cu are analyzed in terms of the standard optical model and the reformulated optical model. Good fits are obtained at both energies with both models, but the simple optical model is superior at 50 MeV. Values of the mean-square radius of the two-body force, $\langle r^2\rangle_d$, obtained from these analyses depend strongly on which part of the data is fitted, and it is concluded that information on matter radii may be extracted provided a value of $\langle r^2\rangle_d$ obtained by other means is used. Differences in optical-model parameters between the pair of isotopes are calculated using difference function analysis, and this technique is compared with the conventional method. The former method reduces the errors in the differences by up to a factor of three. Differences in the parameters are compared with those obtained from the analysis of other data from pairs of isotopes in this energy region. (auth)

50690 ELECTROMAGNETIC PROPERTIES OF ^{45}Ti EXCITED STATES. Iyengar, K. V. K.; Robertson, B. C. (Univ. of Alberta, Edmonton). Nucl. Phys.; A171: No. 1, 73-86(1971).

The lifetimes of several levels in ^{45}Ti were measured via the reaction ^{45}Sc(p,nγ)^{45}Ti by using the Doppler-shift-attenuation method. The presence of levels at 1.958, 2.260, and 2.432 MeV excitation observed by a neutron time-of-flight technique are reported. Spins of $9/2^-$ and $11/2^-$ are assigned to the levels at 1.354 and 1.468 MeV, respectively, from angular distribution measurements of their γ-decay modes and from the lifetime determinations. (auth)

50691 GAMMA-RAY DECAY OF THE LOW-LYING LEVELS OF ^{34}Cl. Snover, K. A. (State Univ. of New York, Stony Brook); McDonald, J. M.; Fossan, D. B.; Warburton, E. K. Phys. Rev., C; 4: No. 2, 398-405(Aug 1971).

The excitation energies and γ-ray decay modes of the low-lying states of ^{34}Cl were studied using the ^{32}S(^{3}He, pγ)^{34}Cl reaction. Some lifetime limits were obtained by the Doppler-shift-attenuation method. The lifetimes of the $(J^\pi,T) = (1^+,0)$ levels at 461 and 6 666 keV and the $(2^+,0)$ level at 1230 keV were measured to be 7.1 ± 0.7, 12.8 ± 1.0, and 19.4 ± 1.4 psec, respectively, by using the recoil-distance (plunger) technique with the ^{31}P(α,nγ)^{34}Cl reaction. The transition strengths from these three levels are discussed qualitatively in terms of calculations involving simple configurations, and are compared with recent detailed shell-model calculations. (auth)

50692 SELF-CONSISTENT STUDY OF EVEN NICKEL ISOTOPES WITH CENTRAL YUKAWA AND HAMADA–JOHNSTON INTERACTIONS. Chandra, Harish; Rustgi, M. L. (State Univ. of New York, Buffalo). Phys. Rev., C; 4: No. 2, 406-14(Aug 1971).

By employing Hartree–Fock (HF), spherical BCS, and Hartree–Fock–Bogolyubov approximations and using central Yukawa (CY) and Kuo–Brown renormalized matrix elements for the Hamada–Johnston (HJ) interaction, a study of the behavior of nuclear shapes for the even Ni isotopes is carried out. Nuclear properties, such as binding energy with respect to the ^{40}Ca core, intrinsic quadrupole and hexadecapole moments, and spectroscopic pickup strengths (with special emphasis on the pickup strength for the $j = 7/2$ state), are calculated for different shapes and compared. It is found that the theoretical values of binding energy corresponding to shapes with minimum energy compare well with the experimental values. Addition of more neutrons to ^{56}Ni decreases considerably the occupation probability for the protons in the $j = 7/2$ state for all the shapes and approximations for the HJ interaction. With the CY interaction, the pickup strength in the $j = 7/2$ state is not much affected for the BCS solution but it decreases in other approximations. It is found that the self-consistent solution for ^{56}Ni corresponding to the HJ interaction does not converge to a spherical shape; instead, it gives an oblate HF solution. (auth)

50693 STUDY OF ^{49}Cr USING THE ^{50}Cr(^{3}He,α)^{49}Cr REACTION AND ^{50}Cr(^{3}He,αγ)^{49}Cr ANGULAR CORRELATIONS. Blumenthal, D. A.; Zurmuehle, R. W.; Balamuth, D. P. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., C; 4: No. 2, 415-33(Aug 1971).

Energy levels in ^{49}Cr were studied using the ^{50}Cr(^{3}He,α)^{49}Cr reaction. Angular distributions of α particles were measured and compared with distorted-wave Born-approximation calculations to determine l values. α–γ angular correlations were also measured. The following spin–parity assignments are consistent with the results for the levels indicated: 0.27 MeV, $7/2^-$; 1.07 MeV, $(5/2^-, 9/2^-)$; 1.57 MeV, $(5/2^-, 7/2^-, 11/2^-)$; 1.71 MeV, $(1/2^-, 3/2^-)$; 1.74 MeV, $3/2^-$; 1.98 MeV, $3/2^+$; 2.43 MeV, $5/2^-$; 2.58 MeV, $1/2^+$; 2.61 MeV, $3/2^-$; 3.24 MeV, $5/2^-$; 3.51 MeV, $(5/2^-, 7/2^-)$; 3.93 MeV, $1/2^-$; 4.76 MeV, $7/2^-$; 5.57 MeV, $3/2^+$; 6.43 MeV, $1/2^+$; 6.47 MeV, $1/2^+$; and 6.76 MeV, $1/2^+$. Branching ratios for the decays of these levels were measured. Multipole mixing ratios were extracted from the correlation data. (auth)

50694 ALPHA-PARTICLE SCATTERING BY ^{20}Ne AT 16.8 MeV. Frickey, J. W.; Eberhard, K. A.; Davis, R. H. (Florida State Univ., Tallahassee). Phys. Rev., C; 4: No. 2, 434-43(Aug 1971).

Energy-averaged angular distributions were measured at 16.8 MeV for scattering to the ground state and first two excited states of ^{20}Ne. Direct and compound-nuclear contributions are estimated. Optical-model fits to the elastic scattering data with three discrete real potentials (V = 34, 57, and 83 MeV) are greatly improved by an l-dependent absorption. Only two well depths (50 and 80 MeV) give reasonable 0^+-2^+ coupled-equation fits. Slightly better results for $0^+-2^+-4^+$ coupling are obtained by including a j-dependent absorption with V = 50 MeV, W = 4.0 MeV, R = 4.94 F, $\beta_2 = 0.40$, and $\beta_4 = 0.0$. (auth)

50695 STUDY OF ^{44}Ti BY THE ^{40}Ca(α,γ)^{44}Ti REACTION. Simpson, J. J. (Univ. of Guelph, Ont.); Dixon, W. R.; Storey, R. S. Phys. Rev., C; 4: No. 2, 443-60(Aug 1971).

The ^{40}Ca(α,γ)^{44}Ti reaction was used to study the nucleus ^{44}Ti. The mass excess of ^{44}Ti was determined to be −37,541 ± 10 keV. Radiative yields and angular distributions of de-excitation γ rays from resonances at 4.22, 4.26, and 4.52 MeV α energy and angular distributions of γ rays between bound levels were measured using Ge(Li) detectors. Bound states were found at 1083 (2^+), 1905 (0^+), 2454 (4^+), 2531 (2^+), 2886 (2^+), 3175, 3415 (2,3), 3645, and 3942 keV, and mixing ratios and branching ratios for the decays of some of these levels are reported. The ground state and first excited 2^+ and 4^+ states can be explained in terms of $(fp)^4$ configurations. Some of the other low-energy states probably require interpretation in terms of particle–hole configurations. Relative reduced E2 transition strengths from the 2531-keV (2^+)

state are determined and suggest that the 1905- and 2531-keV states may be the beginning of a rotational band. (auth)

50696 LIFETIMES OF SOME EXCITED STATES IN ^{24}Mg, ^{26}Mg, AND ^{28}Si. Haskett, J. A.; Bent, R. D. (Indiana Univ., Bloomington). Phys. Rev., C; 4: No. 2, 461-70(Aug 1971).

Lifetimes of several low-lying levels in ^{24}Mg, ^{26}Mg, and ^{28}Si were measured using the Doppler-shift-attenuation method. The levels were populated by the X(α,α')X* reaction by using 22-MeV α particles. The backscattered α particles were detected in an annular surface-barrier particle detector, and coincident γ rays resulting from the decay of the nuclear states were detected by a 16.7-cm^3 lithium-drifted germanium detector. A new form for the velocity of the recoiling ions as a function of time, which is suitable for heavy target backings and high initial recoil velocities (~0.03c), was used. The results for the mean lifetimes, in units of 10^{-15} sec, for the excited states in parentheses (MeV) are the following: ^{24}Mg(4.12) 169 ± 34, (4.23) 185 ± 33, (5.23 173 ± 46, (6.01) 124 ± 20; ^{26}Mg(2.94) 60^{+17}_{-20}, ^{28}Si(4.61) 83^{+15}_{-12}. These results are compared with previously reported values, and best averages are suggested. (auth)

50697 CORE EXCITED STATES IN ^{49}Ca STUDIED IN THE REACTION ^{48}Ca(d,pγ)^{49}Ca. Canada, T. R. (Univ. of Pittsburgh); Ellegaard, C.; Barnes, P. D. Phys. Rev., C; 4: No. 2, 471-4 (Aug 1971).

The decay modes of 10 ^{49}Ca states were investigated utilizing the reaction ^{48}Ca(d,pγ)^{49}Ca*. On the basis of the resulting decay scheme and some previously measured l_n values, J^π assignments of ($\frac{3}{2}^-$) and ($\frac{3}{2}$,$\frac{1}{2}$) are made to the 3.586- and 4.272-MeV levels, respectively. A new level at 4.885 MeV is assigned J = ($\frac{3}{2}$,$\frac{7}{2}$). The ^{49}Ca level structure is discussed in terms of particle–core coupling models. (auth)

50698 MEASUREMENT AND ANALYSIS OF GROUND-STATE BAND TRANSITIONS AND 2$^{+\prime}$ STATES IN ^{78,80,82,84}Kr FROM (α, xnγ). McCauley, D. G.; Draper, J. E. (Univ. of California, Davis). Phys. Rev., C; 4: No. 2, 475-93(Aug 1971).

Ground-state band levels to 6^+ in ^{84}Kr, 6^+ in ^{82}Kr, 8^+ in ^{80}Kr, and 10^+ in ^{78}Kr were identified by 20- to 65-MeV (α,x$n\gamma$) reactions with enriched Se targets for x = 2, 3, and 4. The data are in-beam and radioactive γ spectra, angular distributions, relative and absolute excitation functions, and ~3-nsec time distributions. All transitions in the ground-state bands are ≥95% prompt (≥ 3 nsec), except for those in ^{84}Kr; in this nuclide the $6 \rightarrow 4$, $4 \rightarrow 2$, and $2 \rightarrow 0$ transitions have the same intensities of long-lived (≥ 200-nsec) component in addition to the prompt component. Multipole-mixing ratios of three other transitions in ^{82}Kr are obtained from the angular distributions. The systematics of level energies in the ground-state bands of various Se, Kr, Mo, and Ru isotopes are analyzed with a phenomenological equation. This reveals three limiting types of nuclei. (auth)

50699 STUDY OF THE FIRST 3$^-$ LEVELS OF ^{40}Ca AND ^{208}Pb NUCLEI. Tatischeff, B. (Institut de Physique Nucleaire, Orsay, France); Bimbot, L.; Brissaud, I.; (and others). Phys. Rev., C; 4: No. 2, 494-7(Aug 1971).

Differential cross sections for the inelastic scattering of 166-MeV α particles from the 3$^-$ levels of ^{40}Ca and ^{208}Pb are presented. A distorted-wave Born-approximation microscopic analysis is made by utilizing an effective α-nucleon interaction previously determined from a study of elastic scattering. In considering the results obtained, various aspects of nuclear structure implicit in the calculations of microscopic wave functions are implicated: the effective nucleon–nucleon interaction, the importance of nucleon correlations, and the extent of the configuration space. Electromagnetic transition probabilities and inelastic electron scattering form factors calculated with the microscopic wave functions used in the α-particle analysis are compared with experimental results. No effective charge is required to obtain agreement. (auth)

50700 STUDIES OF THE LOW-LYING STATES OF ^{41}K VIA THE REACTIONS ^{41}Ar(β^-)^{41}K AND ^{41}K(p,p'γ)^{41}K. Jundt, F. (Laboratoire de Physique Nucleaire de d'Instrumentation Nucleaire, Strasbourg); Aslanides, E.; Gallmann, A.; Warburton, E. K. Phys. Rev., C; 4: No. 2, 498-504(Aug 1971).

The 110-min β^- decay of the $\frac{7}{2}^-$ ground state of ^{41}Ar to excited state of ^{41}K was investigated by observation of the deexcitation ^{41}K γ rays with a Ge(Li) detector. In addition, both (p',γ) coincidence measurements and a magnetic spectrometer study were made of the reaction ^{41}K(p,p')^{41}K at proton energies between 5.3 and 5.8 MeV. The (p',γ) work gave γ-ray decay-mode information used in the analysis of the β^--decay studies. The magnetic spectrometer studies confirmed a new level of ^{41}K at 1594 ± 3 keV observed in the (p',γ) work. The β^- decay to the ^{41}K sixth excited state (E_x = 1677.0 ± 0.3 keV) observed previously by Pratt was confirmed. The branch was found to be (5.2 ± 0.5) × 10^{-2}%, this value corresponding to an allowed log f_0t value of 7.68 ± 0.04. Rather severe upper limits were placed on any other branches to excited states except the major one to the $\frac{7}{2}^-$ state at 1294 keV. (auth)

50701 BEAMSTOP EXPERIMENT AT 29.4 GeV. Van Ginneken, A.; Borak, T. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 3, 746-7(Jun 1971).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971). See CONF-710308.

Data on ^{18}F production in aluminum foils embedded in a large steel beamstop bombarded by 29.4 GeV protons are presented and compared with calculated results. (auth)

50702 DISTORTED WAVE BORN APPROXIMATION ANALYSIS OF ^{58}Ni(d,p)^{59}Ni. Samaddar, S. K. (Saha Inst. of Nuclear Physics, Calcutta). pp 1-3 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208–(Vol.2).

50703 TOTAL CROSS-SECTION MEASUREMENT IN THE ^{37}Cl(p,n)^{37}Ar REACTION. Gupta, S. K.; Kerekatte, S. S.; Divatia, A. S. (Bhabha Atomic Research Centre, Trombay, India). pp 8–10 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208–(Vol.2).

50704 MEASUREMENT OF THE TOTAL ^{48}Ca(p,n)^{48}Sc REACTION CROSS SECTION AROUND THE ISOBARIC ANALOG STATE AT E_p = 1.976 MeV. Sekharan, K. K; Mehta, M. K. (Bhabha Atomic Research Centre, Bombay). pp 11–13 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208–(Vol. 2).

50705 ANGULAR DISTRIBUTION OF GAMMA-RAYS FROM ^{59}Co(p,nγ)^{59}Ni AND ^{51}V(p,nγ)^{51}Cr REACTIONS. Lal, B.; Sahai, Beldev (Tata Inst. of Fundamental Research, Bombay). pp 14–19 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208–(Vol. 2).

50706 PROTON TRANSFER REACTION ON ^{66}Zn. Betigeri, M. G. (Bhabha Atomic Research Centre, Trombay, India). pp 26–8 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208–(Vol.2).

50707 SPECTROSCOPIC FACTORS FOR PICKUP REACTIONS. Puttaswamy, N. G. (Bangalore Univ., India). pp 62–4 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208–(Vol.2).

50708 HARTREE-FOCK ORBITALS WITH S-STATE INTERACTIONS. Kulkarni, D. R.; Pandya, S. P. (Physical Research Lab., Ahmedabad, India). pp 89–92 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208–(Vol.2).

50709 PAIRING CORRELATIONS IN NICKEL ISOTOPES. Gunye, M. R.; Khadkikar, S. B. (Tata Inst. of Fundamental Research, Bombay). pp 93–4 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208–(Vol.2).

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50710 SHAPE OF ^{24}Mg GROUND STATE. Khadkikar, S. B.; Gunye, M. R. (Tata Inst. of Fundamental Research, Bombay). pp 95–8 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

50711 LIFETIMES OF THE EXCITED LEVELS IN ^{51}V AND ^{90}Y. Singh, H.; Sethi, B. (Saha Inst. of Nuclear Physics, Calcutta). pp 165–9 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

50712 TECHNIQUE OF ABSOLUTE STANDARDIZATION OF ^{60}Co USED AT BARC FOR INTERNATIONAL INTERCOMPARISON. Srivastava, P. K.; Khera, G. D. (Bhabha Atomic Research Centre, Trombay, India). pp 285–8 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

50713 DECAY OF ^{71m}Zn. Singh, H.; Sethi, B.; Tikku, V. K. (Saha Inst. of Nuclear Physics, Calcutta). pp 404–7 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol. 2).

50714 DECAY OF ^{74}Ga AND ENERGY LEVELS OF ^{74}Ge. Singh, H.; Sethi, B. (Saha Inst. of Nuclear Physics, Calcutta). pp 408–11 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

50715 DECAY OF 15 MIN-^{65}Ga TO ^{65}Zn. Basu, D. (Saha Inst. of Nuclear Physics, Calcutta). pp 412–14 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

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Refer also to abstracts 48943, 48983, 50051, 50105, 50276, 50638, 50661, 50678, 50711, 50804, 50817, 50818, 50839, 50845, and 51226.

50716 (ANL–7814) ANALYSIS OF INTERMEDIATE STRUCTURE IN FISSION CROSS SECTION OF ^{239}Pu. Kikuchi, Yasuyuki (Argonne National Lab., Ill.). May 1971. Contract W-31-109-eng-38. 29p. Dep. NTIS.

The intermediate structure observed in recent fission-cross-section data for ^{239}Pu is analyzed below 8 keV by using the formulation developed by Weigmann and by assuming a double-humped fission potential. The behavior of the intermediate structure can be expressed with 36 sets of intermediate resonance parameters which express the physical properties of the Class II states. This intermediate-resonance-parameter representation can describe the structure accurately with a reasonably small number of parameters and reduce computer memory requirements for nuclear data input to reactor calculations. The mean level spacing and the mean width of the intermediate structure fall between 190 and 390 eV and between 45 and 90 eV, respectively. From these mean values, the shape of the double-humped fission potential is estimated, and some assumptions on which the formulation by Weigmann is based can be justified. The effect of the intermediate structure on effective cross sections is discussed for a homogeneous system with the potential scattering cross section of 100 b. (auth)

50717 (ANL–7815) ANALYSIS OF INTERMEDIATE STRUCTURE IN FISSION CROSS SECTION OF ^{241}Pu. Kikuchi, Yasuyuki (Argonne National Lab., Ill.). May 1971. Contract W-31-109-eng-38. 14p. Dep. NTIS.

The intermediate structure observed in recent fission-cross-section data is analyzed by assuming a double-humped fission potential. From channel theory, the fission width of the 3^+ state is considered to have this structure. The s-wave strength function deduced from resolved resonance analysis ($s_0 = 1.3 \times 10^{-3}$) is found to be too small to describe the peaks of the structure. The value from total-cross-section measurements ($s_0 = 1.9 \times 10^{-3}$) is used in this analysis. Therefore the fission width obtained is smaller and the α value obtained is larger than those from the ENDF/B Version II file. The mean values of level spacing and width of the Class II states are 270 and 70 eV, respectively. From these values, the fission potential shape is estimated. (auth)

50718 (JINR–E7–5887) THE POSSIBILITY OF HEAVY ION ACCELERATION IN THE INTERACTION OF HIGH ENERGY NUCLEONS WITH NUCLEI. Flerov, G. N.; Gangrskii, Yu. P.; Orlova, O. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1971. 10p. Dep. NTIS (U. S. Sales Only).

The upper limit of the production cross section of recoil nuclei in the interactions of relativistic neutrons with a tantalum target was measured. Neutrons were received in the interaction of 76-GeV protons with Fe nuclei. For detecting recoil nuclei and fission fragments mylar films were used. The neutron flux passing through the target was estimated to be 10^{11} cm^{-2}. The target square was 44 cm^2. The upper limit of the production cross section of recoil nuclei is estimated to be 2.10^{-33} cm^2. (auth)

50719 (JINR–P6–5878) INVESTIGATION OF THE DECAY OF ^{205}Rn, ^{207}Rn, ^{209}Rn, AND ^{207}At. Kempisty, T.; Morek, T.; Peker, L. K.; Petrozolin, K.; Chojnacki, S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). Jun 1971. 10p. (In Russian). Dep. NTIS (U. S. Sales Only).

The gamma spectra accompanying β decay of ^{205}Rn, ^{207}Rn, ^{209}Rn produced in the reactions ^{197}Au(^{15}N, xn)$^{212-x}$Rn, ^{nat}Pt(^{16}O,xn)Rn, and ^{nat}Tl(^{11}B,xn)Rn were investigated. The γ radiation following β decay of ^{207}At which was accumulated after the ^{207}Rn beta decay was also studied. The level schemes of ^{205}At, ^{207}At, ^{209}At, and ^{207}Po are assumed on the data obtained. (auth)

50720 (JINR–P6–5879) INVESTIGATION OF EXCITED LEVELS OF ^{196}Pb AND ^{194}Pb NUCLEI. Chojnacki, S.; Morek, T.; Peker, L. K.; Kempisty, T.; Petrozolin, K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). Jun 1971. 10p. (In Russian). Dep. NTIS (U. S. Sales Only).

Levels of even–even lead isotopes were investigated in the decay of bismuth isotopes produced in the reactions ^{181}Ta(^{22}Ne,xn) $^{203-x}$Bi and ^{181}Ta(^{20}Ne,xn) $^{201-x}$Bi. The level schemes of ^{196}Pb and ^{194}Pb were assumed on the basis of the measurements of gamma spectra and gamma–gamma coincidences. (auth)

50721 (KFK–1338) PRODUCTION OF EINSTEINIUM IN REACTORS AT MEDIAN NEUTRON FLUX. Eberle, S. H.; Reinhardt, J.; Gantner, E.; Krueckeberg, Ch. (Kernforschungszentrum, Karlsruhe (West Germany), Institut fuer Radiochemie). Apr 1971. 18p. (In German). Dep. NTIS (U. S. Sales Only).

The neutron capture cross section and the resonance integral of ^{252}Cf were determined by analysis of californium irradiated in the FR2 reactor: $\sigma_{c,o} = 20.0$ b, $I_c = 40$ b. Using these values, the yields of ^{253}Cf and ^{253}Es for neutron fluxes between 1×10^{13} and 5×10^{14} $N_{th}/cm^2 \cdot$ sec as a function of the irradiation time have been calculated; the results are given in a diagram and in tables. The production of ^{253}Es in reactors of medium neutron flux gives acceptable yields. (auth)

50722 HYPERFINE MAGNETIC FIELDS AT THORIUM AND URANIUM NUCLEI IN IRON METAL. Ansaldo, E. J.; Grodzins, L. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Lett.; 34B: 43-5(18 Jan 1971).

The perturbation of the $\alpha-\gamma$ angular correlation after recoil implantation has been measured for the 2^+ states of ^{228}Th and ^{234}U implanted into copper and iron metals. Substantial precessions and attenuations are observed in time-integral measurements. Assuming theoretical g-factors and the applicability of the Abragam–Pound theory for combined interactions, the hyperfine magnetic fields in iron are $H_{Th}(Fe) = -0.31 \pm 0.06$ MOe and $H_U(Fe) = -0.56 \pm 0.16$ MOe. (auth)

50723 ACCURACY OF THE PHOTON-DIFFERENCE METHOD USED IN HIGH-ENERGY PHOTONUCLEAR EXPERIMENTS. Tesch, K. (Deutsches Elektronen-Synchrotron, Hamburg). Nucl. Instrum. Methods; 95: No. 2, 245-52(1971).

The accuracy in calculating the cross sections per photon, σ_k, from a set of measured cross sections per equivalent γ quantum, σ_q, is discussed. Four commonly used approximations for the bremsstrahlung spectrum and corrections for finite target thick-

nesses and collimator angles are reviewed. For the calculation of σ_k, a simple unfolding method is proposed, in the methods known for solving the Fredholm integral equation of the first kind, the necessary smoothing of the resulting curve is derived from the mean experimental error of σ_q. For some examples of cross sections that may be encountered in photonuclear research above 100 MeV, the mean error of σ_K caused by inaccurate knowledge of the bremsstrahlung spectra is calculated by the unfolding method and by the experimental errors of σ_q. (auth)

50724 COMPENSATION FOR THE ENERGY DEPENDENCE IN LIFETIME MEASUREMENTS. Rougny, R.; Troncy, A.; Berkes, I.; (and others) (Univ. Claude Bernard, Lyon). Nucl. Instrum. Methods; 95: No. 2, 333-5(1971). (In French).

An electronic compensation for the centroid shift of the time correlation versus energy is developed. After compensation the centroid shift is smaller than 15 ps in an energy range 100 to 500 keV. The time resolution measured with a ^{60}Co source is improved by a factor of 3 for lateral window widths 150 to 650 keV. (auth)

50725 MEASUREMENT OF THE LONGITUDINAL POLARIZATION OF ELECTRONS FROM SOME FIRST-FORBIDDEN BETA DECAYS. Blinowska, K. J.; Chojnacki, S.; Czyzewski, T. (Univ., Warsaw). Acta Phys. Pol.; B2: No. 2-3, 175-82(Apr-Jun 1971).

The longitudinal polarization of electrons from the first-forbidden β transitions in ^{122}Sb, ^{141}Ce, ^{170}Tm, ^{175}Yb, and ^{177}Lu isotopes was measured by Mott scattering. The results were compared with theoretical predictions based either on the shell model with spherical potential wave functions or on the Nilsson and Saxon–Woods wave functions. The value of the matrix elements ratio $\langle i\alpha\rangle/\langle r\rangle$ was found to vary considerably, depending on the isotope. (auth)

50726 INVESTIGATION OF THE DECAY OF ^{151}Tb. Gonsior, M.; Gromova, I. I.; Iskhakov, G. I.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol.; B2: No. 2-3, 307-25(Apr-Jun 1971). (In Russian).

The decay of ^{151}Tb was investigated. The spectra of gamma rays, gamma–gamma coincidences, conversion-electron spectra and electron–electron coincidences were measured. The level scheme of ^{151}Gd populated from the decay of ^{151}Tb is proposed. (auth)

50727 INTERNAL-CONVERSION STUDIES OF HIGH-ENERGY TRANSITIONS IN ^{228}Th. Amov, B. G. (Joint Inst. for Nuclear Research, Dubna, USSR); Kotlinska, B.; Kurcewicz, W. Acta Phys. Pol.; B2: No. 2-3, 337-9(Apr-Jun 1971).

In the ^{228}Pa → ^{228}Th decay selected parts of the conversion-electron spectrum were measured in order to clear up the discrepancies between the data on γ-transition energies. (auth)

50728 ENERGY LEVELS OF ^{133}Cs EXCITED BY MEANS OF THE (n,n′γ) REACTION. Kikuchi, Shiroh (Japan Atomic Energy Research Inst., Tokai). Nucl. Phys.; A171: No. 3, 480-96(1971).

The energy levels of ^{133}Cs have been studied by means of the (n,n′γ) reaction in the energy range 0.5 to 1.2 MeV. A 17 cm^3 Ge(Li) detector, associated with a pulsed-beam time-of-flight system, was used to detect γ-rays. Nine levels of 605, 633, 641, 706, 768, 787, 819, 873 and 917 keV have been found. The spin assignments are made by comparing the observed angular distributions of γ-rays and level excitation functions with those calculated on the basis of the statistical theory. (auth)

50729 MAGNETIC MOMENT OF ^{207}Pb AND THE SHIELDING OF LEAD IONS BY WATER. Lutz, O.; Stricker, G. (Univ., Tuebingen, Ger.). Phys. Lett.; 35A: No. 6, 397-8(12 Jul 1971).

The ratio of the Larmor frequencies of ^{207}Pb and ^{2}H has been measured by the NMR method and a magnetic moment has been calculated for ^{207}Pb. The shielding of the lead ion by water has been evaluated: $\sigma = -1.78$ (1)%. A large solvent isotope effect has been found. (auth)

50730 EFFECT OF ^{240}Pu COMPOUND-NUCLEUS STATE ON THE FISSION-FRAGMENT MASS AND KINETIC ENERGY DISTRIBUTIONS. Toraskar, Jayashree; Melkonian, E. (Columbia Univ., New York). Phys. Rev., C; 4: No. 1, 267-73(Jul 1971).

Fission-fragment mass and kinetic energy distributions were obtained for fission of ^{239}Pu induced by neutrons filtered through beryllium and by neutrons filtered through samarium. The beryllium filter enhances the contribution of the negative-energy resonance level to the fission cross section, and the samarium filter enhances the contribution of the 0.297-eV level. Surface-barrier detectors were used for the simultaneous measurement of both the fragment energies. Absolute fragment energies were calculated by using mass-dependent pulse-height energy relations. The average total kinetic energy of the fragments produced in the fission induced by samarium-filtered neutrons was observed to be 0.75 ± 0.05 MeV greater than in the case of fission induced by beryllium-filtered neutrons. This result, when combined with the results of other experiments, implies $J = 0^+$ for the negative-energy level and $J = 1^+$ for the 0.297-eV level of ^{239}Pu. The two mass distributions are similar except for a difference in the symmetric fission yield. This difference again implies the same spin assignments as above. The absolute average total kinetic energies were determined with somewhat less accuracy and are found to be 173.0 ± 1.5 and 173.7 ± 1.5 MeV for fissions induced by beryllium- and samarium-filtered neutrons, respectively, as directly measured, and 175.8 ± 1.5 and 176.5 ± 1.5 MeV, respectively, after correction for neutron emission. (auth)

50731 INTERNAL CONVERSION COEFFICIENTS. Rao, M. Raja; Parthasaradhi, K. (Andhra Univ., Waltair, India). Indian J. Phys.; 43: No. 10, 623-5(Oct 1969).

Accurate theoretical total photoelectric cross sections [Schmickley and Pratt, Phys. Rev., 163: 104(1967)] were used to improve the accuracy of previous measurements of internal conversion coefficients [Rao and Jnanananda, Nucl. Instrum. Meth., 36: 261(1965); Curr. Sci., 35: 435(1966); Indian J. Phys., 41: 55(1967)]. Results are reported for ^{134,137}Ba, ^{114}In, and ^{203}Tl. (R.W.R.)

50732 FORBIDDEN α TRANSITIONS. Geilikman, B. T. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 13: 454-5 (Feb 1971). (In Russian).

Forbidden α transitions have been observed in four cases: ^{229}Th → ^{225}Ra, ^{223}Ra → ^{219}Rh, ^{227}Th → ^{223}Ra, and ^{231}Pa → ^{227}Ac. One possible explanation of these transitions is elucidated with the change in the symmetrical deformation parameter during the transitions taken into account. In the calculations of the overall probability of α decay, advantage was taken of the method of scrambling. Differences in the deformation of the nucleus among the four transitions are emphasized and discussed. (K.S.W.)

50733 METHOD OF NONDESTRUCTIVE MEASUREMENT OF THE ABSOLUTE CUMULATIVE ^{140}Ba YIELD OF URANIUM IRRADIATED IN THERMAL AND FAST NEUTRON SPECTRA. Krappel, W.; Seufert, H.; Stegemann, D. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Technol.; 12: No. 2, 226-34 (Oct 1971).

The ^{140}Ba cumulative yield of irradiated uranium was determined absolutely by a nondestructive method. Thin uranium foils were irradiated in the Fast Thermal Zero Power Reactor STARK. To avoid radiochemical separation, the 1596.5 keV gamma activity of ^{140}La, the daughter nucleus of ^{140}Ba, was measured with a high resolution (2.6 keV f.w.h.m.) Ge(Li)-detector. From this ^{140}La activity the absolute ^{140}Ba yield was evaluated from the corresponding absolute fission rate and the detector efficiency known for the 1596.5 keV photopeak. The uranium fission rate in the foil was normalized to the absolute fission rate measured with a calibrated parallel-plate chamber. Calibration of the gamma spectrometer was performed with activated thin La_2O_3 foils having absolute activities determined by $2\pi\beta$-counting. The ^{140}Ba cumulative yield data obtained are 6.29 ± 0.14% for ^{235}U thermal neutron fission and 6.10 ± 0.15(%) and 6.34 ± 0.41(%) for fast neutron fission of ^{235}U and ^{238}U respectively. They are in good agreement (within ±1%) with other reported values. (auth)

50734 EXPERIMENTAL OBSERVATION OF THE NUCLEAR RAMAN EFFECT. Hass, M.; Moreh, R.; Salzmann, D. (Nuclear Research Centre, Negev, Israel). Phys. Lett.; 36B: No. 2, 68-70(23 Aug 1971).

The nuclear Raman scattering of monochromatic γ lines of energies 8533, 8998, and 9298 keV from ^{232}Th and ^{238}U targets has been observed. The measured cross sections are in good agreement with calculated values for elastic and inelastic photon scattering from a deformed nucleus. (auth)

50735 CRYSTAL LATTICE EFFECTS IN THE ^{149}Sm(n,α)^{146}Nd REACTION INDUCED BY THERMAL NEUTRONS. Mueller, D. W.; MacFarlane, R. D.; Beg, K.; Suttle, A. D. Jr. (Texas A and M Univ., College Station). Phys. Lett.; 36B: No. 2, 74-5(23 Aug 1971).

The thermal-neutron-induced reaction ^{149}Sm(n,α)^{146}Nd is influenced by the chemical form and temperature of the target material. The detection of this dependence is due to the rather unique features of the thermal neutron capture of ^{149}Sm which make it particularly sensitive to the effective neutron energy spectrum. (auth)

50736 NEUTRON CROSS SECTIONS FOR ^{151}Eu BELOW 1 eV. Poortmans, F.; Girlea, I.; Fabry, A. (SCK/CEN, Mol, Belg.). Nucl. Phys.; A172: No. 489-98(1971).

XUM

Total and activation cross-section measurements on ^{151}Eu have been performed with monochromatic neutrons between 0.02 eV and 0.75 eV and with thermalized neutrons. The following results have been obtained: $\sigma_{nt}(Eu) = 4590 \pm 70$ b at 0.0253 eV; $\sigma_{n\gamma}(^{151}Eu) = 9184 \pm 140$ b at 0.0253 eV; $\sigma_{act}(^{151}Eu(n,\gamma)^{152m}Eu) = 3236 \pm 120$ b at 0.0253 eV and 2809 ± 120 b in a thermalized neutron spectrum (T = 313 K) giving a Westcott g-factor = 0.87 ± 0.02; the resonance parameters of the bound level are: $E_0 = -3.61 \pm 0.02$ meV, $\Gamma = 95.80 \pm 0.01$ MeV, $\sigma_0\sqrt{|E_0|} = 1696 \pm 70$ b · eV$^{1/2}$; the isomeric ratio $R = \sigma_{act}/\sigma_{n,\gamma} = 0.360 \pm 0.02$ for the bound level, 0.380 ± 0.035 for the 0.321 eV resonance and 0.270 ± 0.012 for the 0.460 eV resonance. The Westcott g(T) function, calculated with the present results agrees very well with experiment. (auth)

50737 PHOTOFISSION OF Tl, Hg, AND Au UP TO 1000 MeV. Emma, V.; Lo Nigro, S.; Milone, C. (Univ., Catania, Italy. Istituto Nazionale di Fisica Nucleare, Catania, Italy. Centro Siciliano di Fisica Nucleare e di Struttura della Materia, Catania, Italy. CNR, Catania, Italy). Lett. Nuovo Cim.; 2: No. 6, 271-4 (7 Aug 1971).

Photofission cross sections were measured for thallium, mercury and gold at 300 to 1000 MeV. The values of the cross sections per equivalent quantum are given. (J.F.P.)

50738 CROSS SECTION OF ^{241}Am(n,γ)^{242}Am REACTION MEASURED WITH A NEUTRON SPECTRUM CLOSE TO THE FISSION SPECTRUM. Ivanova, N. I.; Kobzev, A. N.; Krylov, N. G.; (and others). At. Energy. (USSR); 30: No. 4, 369-72(Apr 1971). (In Russian).

The activation method was used to measure the cross section of the ^{241}Am(n,γ)^{242}Am ($T_{\frac{1}{2}}$ = 16.01 hr) reaction, using a neutron spectrum with energies of 3.8% in the 0 to 0.1 MeV, 13.3% in the 0.1 to 0.4 MeV, 26.9% in the 0.4 to 0.9 MeV, 15% in the 0.9 to 1.4 MeV, 23.8% in the 1.4 to 3.0 MeV, and 11.2% in the >11.2 MeV range. The measurement presented experimental problems in the recording of the β activity of the newly formed ^{242}Am nuclei against the much larger background of the specific α and γ activity of the irradiated ^{241}Am and the fragments formed. Taking into account the 20 hours needed for the chemical separation and purification from fission products, the β activity of ^{242}Am at the target amounted to 3 to 4 × 10^5 disintegrations/min. The decrease of the β activity was recorded for 4 to 5 half-lives of ^{242}Am, after which only the continuous 59.57-keV γ radiation of ^{241}Am was recorded; this allowed separating out the β activity of ^{242}Am. The ^{241}Am at the target was determined by the total α activity. The mean value of the cross section of the ^{241}Am(n,γ)^{242}Am reaction was found to be (240 ± 30) × 10^{-27} cm^2. The over-all experimental error was estimated to be 10 to 12%. (TTT)

50739 VERIFICATION OF THE ^{171}Lu DECAY SCHEME. Balalaev, V. A.; Dzhelepov, B. S.; Uchevatkin, I. F.; Shestopalova, S. A. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 1, 18-26(Jan 1971). (In Russian).

The decay scheme of ^{171}Lu measured previously with a Ge(Li) spectrometer revealed transitions exceeding 853 keV. An attempt was made to use previously obtained electron internal conversion spectra and γ-ray spectra for seeking new transition levels and for verifying the hard transitions and their multipole order. Data obtained revealed seventeen new transitions in EIC spectra, ten of which also appeared in the γ spectra. (R.V.J.)

50740 MEASUREMENT OF THE RADIATIVE CAPTURE/FISSION CROSS SECTION RATIO (α) FOR ^{239}Pu IN THE 0.1- TO 30-keV NEUTRON ENERGY RANGE. Kurov, M. A.; Ryabov, Yu. V.; Don Sik, So.; (and others). At. Energ. (USSR); 30: No. 4, 362-9(Apr 1971). (In Russian).

In view of the relation of α of ^{239}Pu with the breeding coefficient, this factor is very important for optimizing fast breeder parameters. In the absence of precise data, measurements were carried out to determine $\alpha(E) = \sigma_{n\gamma}(E)/\sigma_f(E)$ in the 0.1 to 30 keV range by the time-of-flight method, using a 225-m-long flight path at a resolution of ~220 and ~15 sec/m. The measurement was based on a comparison of the count rate of an ionization fission chamber containing thin layers of ^{239}Pu and of a large liquid scintillation detector which records the γ radiation from radiative capture and fission from the thin ^{239}Pu layer as a function of the neutron flight time. The results, which ranged from 0.48 ± 0.10 and 0.36 ± 0.08 for the 10.1 to 29.5 keV range to 0.71 ± 0.07 and 0.73 ± 0.05 for the 0.1 to 0.2 keV integral at 15 and 220 n/sec, respectively, did agree with some of the earlier literature data. The large scatter found in the literature is probably due to inadequate technique used to measure the background level which is especially important for linear accelerators for which relatively short 25- to 35-m flight paths are used. (TTT)

50741 MAGNETIC MOMENTS OF CERTAIN EXCITED STATES OF ^{151}Sm, ^{153}Eu, ^{155}Eu, ^{155}Gd, AND ^{161}Dy NUCLEI. Begzhanov, R. B.; Gaffarov, D. G.; Salikhbaev, K. T. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 1, 135-40(Jan 1971). (In Russian).

Experimental studies were carried out on the magnetic moments of the excited states at 104.5 and 167.8, 103.2, 105.0, 86.7 and 105.3, and 25.7 and 74.7 keV on the nuclei ^{151}Sm, ^{153}Eu, ^{155}Eu, ^{155}Gd, and ^{161}Dy, respectively. Data obtained were correlated with theoretical magnitudes and published data. (R.V.J.)

50742 DECAY OF ^{185}Os. Bedike, T.; Dima, C.; Gel'berg, A.; Popesku, I. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 3, 289-97(1971). (In Russian).

The γ single and γγ coincidence spectra were measured with Ge(Li), Si(Li), and NaI(Tl) detectors. The 5-keV transition between the 880.3 and 874.8 keV levels was not found. Only the 767-keV level is fed in the decay of ^{185}Os but not the 880.3 keV one. (auth)

50743 TWO- AND THREE-QUASIPARTICLE STATES IN ^{132}Xe AND ^{131}Xe. Kerek, A.; Luukko, A.; Grecescu, M.; Sztarkier, J. (Research Inst. for Physics, Stockholm). Nucl. Phys.; A172: No. 3, 603-17(1971).

Levels of ^{132}Xe and ^{131}Xe have been studied in ^{130}Te(α,2nγ) and ^{130}Te(α,3nγ) reactions. In ^{132}Xe the $(h_{11/2}, s_{1/2})_{5^-}$, $(h_{11/2}, d_{3/2})_{7^-}$ and $(h^2_{11/2})_{10^+}$ two-quasiparticle states have been investigated. The half-life of the 7$^-$ level was found to be 90 ± 10 ns. The three-quasiparticle states observed in ^{131}Xe arise from the coupling of a $h_{11/2}$ neutron-hole to the levels of ^{132}Xe. The level having the highest-spin value $^{23}/_2{}^+$ (2194.7) keV has been interpreted as a member of the $(h^2_{11/2}, d_{3/2})$ configuration. It decays to the levels $(h^2_{11/2}, s_{1/2})_{6^+}$, $(h^3_{11/2})_{9^-}$, $(h^3_{11/2})_{15^-}$ and $(h_{11/2})_{11/2^-}$ by a straight cascade. The $^{19}/_2{}^+$ level in the cascade was observed to be an isomeric state with $T_{\frac{1}{2}}$ = 14 ± 3 ns. (auth)

50744 GROSS STRUCTURE IN THE SPECTRA OF HELIUM IONS INELASTICALLY SCATTERED FROM HEAVY NUCLEI WITH LARGE ENERGY LOSS. Chenevert, G. (Univ. of Washington, Seattle); Chant, N. S.; Halpern, I.; Glashausser, C.; Hendrie, D. L. Phys. Rev. Lett.; 27: No. 7, 434-6(16 Aug 1971).

Forward-angle spectra of α particles inelastically scattered from heavy nuclei at incident energies up to 90 MeV are found to exhibit a broad but conspicuous plateau. The integrated cross section of this plateau constitutes about 25% of the total (α,α′) cross section at an incident energy of 65 MeV. The total (α,α′) cross section is, in turn, about $^1/_6$ of the total reaction cross section. It is suggested that nucleon pickup (to form the unstable nuclei ^{5}He and ^{5}Li) may be responsible for a portion of the plateau-like structure in the observed spectra. (auth)

50745 NEW FIVE-QUASIPARTICLE ISOMERIC STATE IN ^{177}Hf. Ward, T. E.; Haustein, P. E. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett.; 27: No. 10, 685-7(6 Sep 1971).

A new high-spin isomer ^{177m_2}Hf was produced via the reactions ^{176}Yb(α,3n)^{177}Hf and ^{180}W(p,pα5n)^{177}Hf. It is interpreted as a $K^\pi = {}^{37}/_2{}^-$ five-quasi-particle state. Seven γ rays attributed to the decay of this new isomer, as well as the γ radiation from 1.1-sec ^{177m_1}Hf in equilibrium, decayed with a (51.6 ± 1.6)-min half-life. These γ rays result from de-excitation of an isomeric level in ^{177}Hf at 2739.7 keV to the rotational band members of the $K^\pi = {}^{23}/_2{}^+$ isomeric state. (auth)

50746 LIFETIME AND DECAY MODES OF THE 84.6 keV ISOMER OF ^{196}Au. Rosner, B.; Felsteiner, J.; Lindeman, H.; Zellermayer, D. (Technion-Israel Inst. of Tech., Haifa). Nucl. Phys.; A172: No. 3, 643-51(1971).

The half-life of the first excited state of ^{196}Au has been measured to be 8.2 ± 0.2 s. The 84.6-keV γ-transition in the decay of this isomeric state has been observed, and a value of $\alpha_T = 240 \pm 50$ for the total conversion coefficient was evaluated. These results support the assumption that this isomer decays to the ground state by an E3 transition. (auth)

50747 CALCULATION OF THE QUADRUPOLE MOMENTS IN Cd AND Te ISOTOPES. Sips, L. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Lett.; 36B: No. 3, 193-5(6 Sep 1971).

Admixtures of two into the one-phonon states corresponding to the third-order anharmonicity are calculated evaluating the triangular graphs with the particle-vibration coupling. Quadrupole moments thus obtained are compared with the experimental findings in Cd and Te isotopes. (auth)

50748 LEVEL STRUCTURE OF ^{97}Tc FROM THE DECAY OF 2.9 d ^{97}Ru. Phelps, M. E.; Sarantites, D. G. (Washington Univ., St. Louis). Contracts AT(11-1)-1530; AT(11-1)-1760. Nucl. Phys.; A171: No. 1, 44-58(1971).

The level structure of ^{97}Tc was investigated from the decay of 2.9-d ^{97}Ru. Singles γ-ray energy and intensity measurements were taken with a 42-cm^3 high-resolution Ge(Li) detector in an anti-Compton arrangement, which employed a large Na(Tl) annular detector. The following new very weak γ-ray transitions were observed in the decay of ^{97}Ru: 114.34 ± 0.07, 477.7 ± 0.6, 850.1 ± 0.4, and 898.19 ± 0.15 keV. From the $\gamma-\gamma$ coincidence relationships established in this work via extensive experiments employing two Ge(Li) detectors it was concluded that levels at 96.5, 215.71, 324.49, 656.82, 785.05, 855.45, 969.79, and 994.69 keV in ^{97}Tc are populated in the decay of ^{97}Ru. The population of two additional levels at 574.2 and 946.5 keV is discussed. Precision measurements of the K-shell conversion coefficients for eight transitions in ^{97}Tc were made with the aid of a Si(Li)–Ge(Li) conversion-coefficient spectrometer. From the α_K value determined in this work for the 216-keV transition, its multipolarity is found to be M1 with (10 ± 4%) admixture. From log-ft and α_K values determined in this work and from γ-ray branching-ratio information, J^π assignments were made for eight levels and limits were placed for the two remaining levels. The α_K value for the 336-keV transition in ^{95}Tc following ^{95}Ru decay was also measured and found to be $(10.4 \pm 0.5) \times 10^{-3}$, which is consistent with an M1 transition with (11 ± 9)% E2 admixture. The level structure and trends in ^{97}Tc and ^{99}Tc isotopes are examined and discussed in relation to recently published results on calculated levels in these isotopes on the basis of an extended quasiparticle-phonon coupling model for the nucleus; only moderate qualitative agreement is found. (auth)

50749 NUCLEAR ISOMERISM IN ^{138}Cs AND ^{138}Ba. Carraz, L. C.; Monnand, E.; Moussa, A. (Centre d'Etudes Nucleaires, Grenoble, France, Institut des Sciences Nucleaires, Grenoble, France). Nucl. Phys.; A171: No. 1, 209-24(1971). (In French).

A new isomer in ^{138}Cs with a half-life of 2.90 ± 0.10 min was discovered. This isomer feeds through β decay a metastable level ($T_{\frac{1}{2}}$ = 0.8 μs) in ^{138}Ba. The decays of ^{138m}Cs and ^{138g}Cs were studied with Ge(Li) detectors. The $\beta-\gamma$ and $\gamma-\gamma$ coincidences were measured. A level scheme is proposed for ^{138}Cs and compared with earlier studies. (auth)

50750 NEUTRON-INDUCED FISSION CROSS SECTIONS OF ^{242}Pu AND ^{244}Pu. Auchampaugh, G. F.; Farrell, J. A.; Bergen, D. W. (Los Alamos Scientific Lab., N. Mex.). Nucl. Phys.; A171: No. 1, 31-43(1971).

The neutron-fission cross sections of ^{242}Pu and ^{244}Pu were measured between 20 eV and 10 MeV by using a nuclear explosion as a source of neutrons. Intermediate structure is observed in both isotopes with the following D_{II} level spacings: ^{242}Pu, $D_{II} = 600^{+188}_{-118}$ eV; ^{244}Pu, $D_{II} = 1500^{+750}_{-375}$ eV. The corresponding D_I level spacings are, for ^{242}Pu, $D_I = 18.7 \pm 1.9$ eV and for ^{244}Pu, D = 11.4 ± 4 eV. In ^{242}Pu a strong increase in the average fission width with energy in the 10 keV to 100 keV energy region was observed. This rise can be interpreted either as a vibrational level in the intermediate well weakly damped into class II compound levels or the opening of a p-wave fission barrier. (auth)

50751 MEASUREMENT OF THE ACTIVITY OF ^{99m}Tc. Shtefan, Kh.; Bazhenov, V. A.; Bochkarev, V. V.; Golubev, Yu. M.; Sokolova, T. N. At. Energ. (USSR); 30: No. 4, 392-3(Apr 1971). (In Russian).

The activity of ^{99m}Tc was measured by means of a 4π β counter with an error of ±2% at the 95% confidence level. The ^{99m}Tc used for the measurements was obtained from a ^{99}Mo generator, by adsorbing the ^{99}Mo on aluminum oxide in the form of sodium phosphormolybdate. The 15 μg/cm^2 thick deposit ensured the absorption of the radiation released during the 2-keV transition, while conversion electrons from the 140- and 142-keV transitions were practically not absorbed at all. A formula was derived to calculate the activity on the basis of the count rate, efficiency of the $4\pi\beta$ counter, and the dead time of the instrument. (TTT)

50752 E2/M1 MIXING RATIOS OF γ-TRANSITIONS FROM THE γ-VIBRATIONAL BAND TO THE GROUND STATE BAND IN ^{152}Sm, ^{154}Gd, AND ^{168}Er. Lange, J.; Rasera, R. L.; Wagner, H. F.; Schaeffner, W. (Univ., Bonn). Nucl. Phys.; A171: No. 1, 92-112 (1971).

By means of the $\gamma-\gamma$ directional correlation method, the E2/M1 mixing ratios of collective γ transitions from the γ-vibrational band to the ground-state rotational band were determined for several deformed doubly even nuclei: ^{152}Sm: $\delta_{22} = 11.0 \pm 1.0$, $\delta_{32} = 8.9 \pm 1.0$; ^{154}Gd: $\delta_{22} = 10.2 \pm 1.0$, $\delta_{32} = 6.6 \pm 0.7$; and ^{168}Er: $\delta_{22} = -65 \pm {}^{30}_{35}$. NaI(Tl) detectors as well as Ge(Li) detectors were used for these measurements. The mixing ratios of the 2^+-2^+ transitions for the nuclei at the beginning of the deformed region are in agreement with the predictions of the theories of Greiner [Nucl. Phys., 80: 417(1966)] and Bès, et al., [Nucl. Phys., 65: 1 (1965)] while for ^{168}Er the mixing ratio differs by nearly an order of magnitude. The ratios δ_{32}/δ_{22} for Sm and Gd are in fair agreement with the theoretical predictions corrected for band mixing. (auth)

50753 LEVELS IN ^{153}Sm. Bennett, Michael J. (Los Alamos Scientific Lab., N. Mex.); Sheline, Raymond K.; Shida, Y. Nucl. Phys.; A171: No. 1, 113-33(1971).

The nuclear levels of ^{153}Sm were investigated by Ge(Li)- and Si(Li)-detector measurements of both high- and low-energy γ rays following thermal neutron capture in ^{152}Sm, and by magnetic spectrograph measurements of the tritons from the ^{154}Sm(d,t) reaction. The observed states are classified within the Nilsson scheme as follows: the mixed $3/2^+$\{[651] + [402]\} ground state band up to the $13/2^+$ member, the $3/2^-$[521] band to the $7/2^-$ member, the $3/2^-$[532] band to the $11/2^-$ member, the $11/2^-$[505] band head, the $3/2^+$\{[402] + [651]\} configuration up to $7/2^+$, and the members up to $7/2^-$ of a $K^\pi = 1/2^-$ band that is partly $1/2^-$[521] and partly vibrational. Also, tentative assignments are made of the $5/2^+$[642], $1/2^-$[530] and $1/2^+$[400] bands, as well as a $K^\pi = 3/2^-$ beta-vibrational band. The $K^\pi = 3/2^+$ rotational bands are severely distorted, presumably owing to Coriolis coupling. An estimate is made of the amount of mixing between the $3/2^+$[651] and $3/2^+$[402] orbitals. Comparisons are made with the level structure of other 91-neutron nuclei and with theoretical calculations. (auth)

50754 SINGLE-PARTICLE ENERGIES AND WAVE FUNCTIONS FOR THE SAXON–WOODS POTENTIAL AND THE LEVELS OF ODD-A NUCLEI IN THE ACTINIDE REGION. Gareev, F. A.; Ivanova, S. P.; Malov, L. A.; Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys.; A171: No. 1, 134-64(1971).

The Saxon–Woods single-particle energies and wave functions are given for the description of deformed nuclei in the region $234 \leqq A \leqq 250$. The energies and the wave functions for the non-rotational states of odd-A nuclei are calculated with the interaction of quasi-particles with phonons taken into account. The latter is found to be more important for nuclei in the actinide region than in the rare-earth one. A rather good description of the energies of low-lying non-rotational states in ^{235}U, ^{237}U, ^{241}Pu, ^{245}Cm, ^{247}Cm, ^{249}Cm, ^{237}Np, ^{241}Am, and ^{249}Bk is obtained. The calculated Saxon–Woods single-particle energies and wave functions may serve as a basis for calculating various characteristics of nuclei in the actinide region. (auth)

50755 NUCLEAR CHARGE DISTRIBUTION IN FISSION: FRACTIONAL CUMULATIVE YIELDS OF ^{132}Te AND ^{134}Te FROM THERMAL-NEUTRON-INDUCED FISSION OF ^{245}Cm AND ^{249}Cf. Troutner, D. E.; Harbour, R. M. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Phys. Rev., C; 4: No. 2, 505-7(Aug 1971).

Fractional cumulative yields of ^{132}Te and ^{134}Te were measured from thermal-neutron-induced fission of ^{245}Cm and ^{249}Cf. The yields, expressed as ratios of atoms of tellurium to atoms of tellurium plus iodine, are 0.94 ± 0.01 and 0.59 ± 0.07 for ^{245}Cm fission and 0.76 ± 0.02 and 0.36 ± 0.05 for ^{249}Cf fission. Fractional yields based on estimated total chain yields are the same as above for ^{132}Te but decrease to 0.56 ± 0.08 and 0.29 ± 0.06 for ^{134}Te. The yields are not consistent with similar yields from ^{233}U and ^{235}U fission. (auth)

50756 Ge(Li)–Ge(Li) STUDY OF THE DECAY OF 14-SEC ^{140}Xe. Schick, W. C. Jr.; Talbert, W. L. Jr.; McConnell, J. R. (Iowa State Univ., Ames). Phys. Rev., C; 4: No. 2, 507-16(Aug 1971).

The γ-ray decay of fission product ^{140}Xe was studied using TRISTAN, the Ames Laboratory on-line isotope separator. Extensive coincidence data were obtained using two Ge(Li) detectors and a buffer tape system. One hundred twenty of the approximately 140 γ rays observed are placed in a level scheme for ^{140}Cs with 27 excited levels. The level density at low energy is quite high, with six excited levels occurring in the first 120 keV. Tentative spin–parity assignments and possible shell-model interpretations are discussed. (auth)

50757 ^{122}In ISOMERS. Takahashi, K.; Swindle, D. L.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Phys. Rev., C; 4: No. 2, 517-21(Aug 1971).

Irradiation of enriched ^{122}Sn with 14.8-MeV neutrons was found to produce a new radioactivity with a half-life of 1.5 ± 0.3 sec; this activity was assigned to an isomer of ^{122}In. The decay of the 7.5-sec ^{122}In isomer was also studied; and a new half-life of 10.0 ± 0.5 sec was determined. (auth)

XUM

50758 (^{3}He,d) REACTION TO BOUND AND QUASIBOUND LEVELS IN ^{93}Tc. Kozub, R. L.; Youngblood, D. H. (Texas A and M Univ., College Station). Phys. Rev., C; 4: No. 2, 535-42(Aug 1971).

The ^{92}Mo(^{3}He,d)^{93}Tc reaction was studied at 35 MeV bombarding energy. Several $T_<$ levels were observed below 6 MeV excitation energy, and evidence is presented for sizable $p_{\frac{1}{2}}^{-2}$ and $f_{\frac{5}{2}}^{-2}$ components in the ^{92}Mo proton configuration. Four deuteron groups, corresponding to $T_> = {}^9/_2$ analogs of low-lying levels in ^{93}Mo, were also observed. Distorted-wave Born-approximation calculations were performed by using form factors calculated for a proton quasi bound by the Coulomb and centrifugal barrier for the proton-unstable levels (≥4.08 MeV excitation energy). The data are well described by the calculations, and reasonable spectroscopic factors are obtained for both $T_<$ and $T_>$ levels. (auth)

50759 ENERGY LEVELS IN ^{156}Gd POPULATED BY 5.4-DAY ^{156}Tb. McMillan, D. J. (Vanderbilt Univ., Nashville); Hamilton, J. H.; Pinajian, J. J. Phys. Rev., C; 4: No. 2, 542-65(Aug 1971).

Gamma-ray singles and coincidence measurements were carried out on the decay of ^{156}Tb with Ge(Li) detectors to study levels of ^{156}Gd. A total of 102 transitions were observed, of which 52 were previously unreported. Of these, 78 were placed in the decay scheme with levels at 88.967, 2^+0; 288.16, 4^+0; 584.74, 6^+0; 1129.52, 2^+0, 1154.23, 2^+2; 1242.5, $1^-(0)$; 1248.08, 3^+2; 1258.4, 2^+0; 1276.22, $3^-(0)$; 1297.7, 4^+0; 1319.69, $2^-(1)$; 1355.52, 4^+2; 1366.6, $1^-(1)$; 1462.4, 4^+0; 1468.5, (4^-1); 1510.67, $4^+(4)$; 1539.0, (3^-1); 1622.64, $5^+(4)$; 1852.09, $3^-(2)$; 1943.41, 3^-; 2045.04, $4^-(4)$; 2103.49, 3^-; 2175.6; 2181.5; and 2232.9 keV. The spin, parity, and K assignments are given where known after each level. Twelve of these levels are reported in this decay for the first time. (auth)

50760 NUCLEAR-ORIENTATION STUDY OF THE DECAY OF ^{125}Sb. Krane, K. S.; Sites, James R.; Steyert, W. A. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 4: No. 2, 565-72(Aug 1971).

The decay of ^{125}Sb to levels of ^{125}Te was investigated using low-temperature nuclear orientation achieved by dilution refrigeration and adiabatic demagnetization. Angular distributions of eight γ rays were observed using Ge(Li) detectors. The values of the E2/M1 γ-transition multipole mixing ratios deduced were (energies in keV) $\delta(636) = +0.341^{+0.003}_{-0.008}$, $\delta(428) = -0.542 \pm 0.016$ and $-1.7 \leq \delta(177) \leq -0.5$. In addition, mixing amplitudes of angular momentum components in the β-radiation fields are extracted. (auth)

50761 NUCLEAR STRUCTURE OF THE N = 82 ISOTONES. Jones, W. P.; Borgman, L. W.; Hecht, K. T.; Bardwick, John; Parkinson, W. C. (Univ. of Michigan, Ann Arbor). Phys. Rev., C; 4: No. 2, 580-600(Aug 1971).

The nuclear structure of the N = 82 isotones ^{138}Ba, ^{139}La, ^{140}Ce, ^{141}Pr, and ^{142}Nd was studied using the single-proton-transfer reactions (^{3}He,d) and (d,^{3}He) on ^{139}La, ^{140}Ce, and ^{141}Pr targets. Distorted-wave analysis of the angular distributions is used to determine angular-momentum transfers and spectroscopic factors for states up to about 3 MeV excitation. The experimental data are compared with recent shell-model calculations, and in particular with the results of calculations using a new simplifying coupling scheme, the pseudo spin–orbit coupling scheme. (auth)

50762 MEASUREMENT OF THE M/L ELECTRON-CAPTURE RATIO IN THE DECAY OF ^{193}Pt. Ravn, H. L.; Boegeholt, P. (Univ. of Aarhus, Denmark). Phys. Rev., C; 4: No. 2, 601-5 (Aug 1971).

A direct measurement of the P_M/P_L electron-capture ratio was made by means of internal-source scintillation-counter techniques. The $Cs_2Pt(CN)_4H_2O$ scintillator crystal was synthesized from a Pt compound containing ^{193}Pt activity, so that the activity occupied lattice positions in the scintillator. The P_M/P_L capture ratio was found to be 0.386 ± 0.014. From this, the exchange correction for the P_M/P_L capture ratio of Pt could be evaluated to be 1.11 ± 0.04, and from the specific activity of the sample it was possible to redetermine the partial half-life for L capture; the result, 73 ± 9 yr, corresponds to a log-ft of 7.2 ± 0.1 and a total half-life of 50 ± 9 yr. (auth)

50763 ^{193}Pt L-ELECTRON-CAPTURE HALF-LIFE. Hopke, Philip K. (Massachusetts Inst. of Tech., Cambridge); Naumann, Robert A. Phys. Rev., C; 4: No. 2, 606(Aug 1971).

The L-electron-capture half-life of ^{193}Pt was remeasured and found to be 94 ± 30 yr. The corresponding log-ft is calculated to be 7.3 ± 0.1. (auth)

50764 OPTICAL-PUMPING DETERMINATION OF THE NUCLEAR MAGNETIC MOMENTS OF THE RADIOISOTOPES ^{193}Hg, ^{193m}Hg, ^{195m}Hg, AND ^{197m}Hg. Moskowitz, P. A.; Liu, C. H.; Fulop, G.; Stroke, H. H. (New York Univ., Bronx). Phys. Rev., C; 4: No. 2, 620-31(Aug 1971).

The technique of optical pumping was used to determine the nuclear magnetic dipole moment of spin-$^3/_2$, 4-h ^{193}Hg and the spin-$^{13}/_2$ isomers, 10-h ^{193m}Hg, 40-h ^{195m}Hg, and 24-h ^{197m}Hg. Nuclear magnetic resonance was observed following orientation of the $6s^2\ {}^1S_0$ ground state. The results are $|^{193}\mu| = 0.617\ 63(18)\mu_N$, $|^{193m}\mu| = 1.0416(3)\mu_N$, $|^{195m}\mu| = 1.0280(2)\mu_N$, and $|^{197m}\mu| = 1.0112(3)\mu_N$, all without diamagnetic correction. Differential hfs anomalies, Δ, are calculated with respect to stable ^{199}Hg with the use of the previously determined values of the magnetic dipole hfs interaction constants for the $6s6p\ {}^3P_1$ level. The results obtained are $^{193}\Delta^{199} = 0.0054(27)$, $^{193m}\Delta^{199} = 0.0108(3)$, $^{195m}\Delta^{199} = 0.0106(2)$, and $^{197m}\Delta^{199} = 0.0156(6)$. (auth)

50765 DECAY OF ^{162}Tm. Chu, Y. Y. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 4: No. 2, 642-6(Aug 1971).

The half-life of ^{162}Tm was determined to be 21.77 ± 0.26 min. Eight γ rays in addition to the Kr K x rays and the annihilation radiation were observed in the decay of ^{162}Tm. Based on the energies and intensities of these γ rays and the level schemes of the even-mass erbium isotopes, a tentative decay scheme of ^{162}Tm is proposed. The K-capture-to-positron ratio in the decay of ^{162}Tm was found to be 12. The maximum positron energy estimated from this ratio and from other results in this work is in gross disagreement with the calculated decay energy of ^{162}Tm. (auth)

50766 DECAY OF ^{143}Ce TO LEVELS IN ^{143}Pr. Ludington, M. A.; Raeside, D. E.; Reidy, J. J.; Wiedenbeck, M. L. (Univ. of Michigan, Ann Arbor). Phys. Rev., C; 4: No. 2, 647-50(Aug 1971).

Gamma radiation following the decay of ^{143}Ce to levels in ^{143}Pr was studied with curved-crystal and Ge(Li) spectrometers. Coincidence spectra were taken with a Ge(Li)–Ge(Li) combination and with a Ge(Li)–NaI(Tl) combinations. Twenty-eight transitions were observed, including a transition of 891 keV, which was previously unreported. The 891-keV transition was placed in the decay scheme on the basis of coincidence data. The 557-keV γ ray known to be associated with the decay of ^{143}Ca was observed in coincidence spectra for the first time. (auth)

50767 $^1/_2{}^+$ GROUND STATES OF ^{127}Cs AND ^{129}Cs. Goldstein, I. V.; de Pinho, A. G. (Univ. Catolica, Rio de Janeiro). Phys. Rev., C; 4: No. 2, 653-6(Aug 1971).

The nature of the $^1/_2{}^+$ ground states of the light isotopes of cesium is discussed in the framework of the unified model. These states are well reproduced by the Nilsson model for oblate shapes, as well as by the intermediate-coupling version of the unified model. (auth)

50768 EQUILIBRIUM AND NONEQUILIBRIUM CONTRIBUTIONS TO THE (p,n) CROSS SECTIONS OF Y, Nb, AND Ta. Grimes, S. M.; Anderson, J. D.; Pohl, B. A.; McClure, J. W.; Wong, C. (Univ. of California, Livermore). Phys. Rev., C; 4: No. 2, 607-19(Aug 1971).

The neutron spectra produced by the ^{89}Y(p,n)^{89}Zr, ^{93}Nb(p,n)^{93}Mo, and ^{181}Ta(p,n)^{181}W reactions were measured at five angles between 15 and 135° for proton energies between 7.8 and 14.8 MeV. It is concluded that the data at low bombarding energies are consistent with a compound-nucleus-reaction mechanism. A constant-temperature level density for energies below the neutron binding energy is found to be appropriate for the residual nuclei ^{89}Zr, ^{93}Mo, and ^{181}W, with nuclear temperatures θ = 0.70, 0.68, and 0.54 MeV, respectively. For bombarding energies above 10 MeV contributions from noncompound processes appear, and at 14.8 MeV these are comparable in magnitude to those produced by compound-nucleus (p,n) reactions. On the basis of the angular distributions and the bombarding-energy dependence the relative fraction of the noncompound cross section due to direct and to pre-equilibrium reaction mechanisms is estimated. The extracted average doorway-state width varies from 350 keV near A = 90 to about 1 MeV for A ~ 180. (auth)

50769 FISSION OF HEAVY NUCLEI AT HIGHER EXCITATION ENERGIES IN A DYNAMIC MODEL. Hasse, Rainer W. (Oak Ridge National Lab., Tenn.). Phys. Rev., C; 4: No. 2, 572-80(Aug 1971).

The dynamic model of asymmetric fission used in calculating the mass and kinetic-energy distributions of the fragments from thermal-neutron-induced fission of ^{235}U is employed to calculate

these distributions for fission at higher excitation energies and for other heavy nuclei at low excitation energies. The model itself is investigated with respect to the semiphenomenological shell correction. It is found that the mass distribution of the fragments in the reaction $^{235}U(n,f)$, which for thermal neutrons is strongly peaked at the heavy-fragment mass 132, goes over into a symmetric mass distribution at a compound-nucleus temperature of about 6 MeV. (auth)

50770 K-SHELL INTERNAL IONIZATION ACCOMPANYING BETA DECAY. Isozumi, Yasuhito; Shimizu, Sakae (Kyoto Univ.). Phys. Rev., C; 4: No. 2, 522-35(Aug 1971).

Internal ionization in the K shell during nuclear β decay was studied experimentally as well as theoretically. The subsequent K x rays were measured in coincidence with emitted electrons for various segments of the β spectra of ^{147}Pm and ^{63}Ni, by using 4π detection geometry for these electrons; the sources were mounted in the electron detectors. The energy-dependent ionization probability $P_K(E_\beta^0)$ was measured as a function of E_β^0, where the parameter E_β^0 is defined as a sum of energies of the β particle and emitted K electron plus the K-shell binding energy of the daughter atom. This energy-dependent and the simultaneously measured total probabilities were found to be in fairly good agreement with theoretical values calculated by the theory developed based on a relativistic one-step treatment of electron shakeoff. From this result it is established that electron shakeoff is the predominant mechanism even for electrons (β particles and K electrons) emitted with very low energies. As to the total ionization probability, it is pointed out that the theoretical values calculated by the simple wave-function-overlap theory by using self-consistent-field wave functions should be improved by multiplying by a correction factor, a function of B_K and E_0, where B_K is the K-shell binding energy of the daughter atom and E_0 is the ordinary maximum kinetic energy of β rays. The theoretical treatment of the phenomenon and future fruitful experiments to be hoped for are also discussed. (auth)

50771 PHENOMENOLOGICAL DESCRIPTION OF ISOBARIC ANALOGUE RESONANCES. (REVIEW). Vertse, Tamas. ATOMKI (At. Kut. Intez.) Kozlem.; 12: No. 4, 213-31(Dec 1970). (In Hungarian).

The phenomenological approach was used to examine the isobaric analog resonances because this method presents the advantage of not being directly involved in the solution of many-body problems, although it does incorporate certain experimental facts into the theory. Although this resonance phenomenon was discovered only a decade ago, it already possesses a rich literature; and it is considered one of the most important fields of contemporary nuclear physics. The concepts of charge independence of nuclear forces and isospin having been defined, the isobaric analog resonances in proton scattering are discussed within the framework of the Lane model, derived from the optical model of the nucleus. In a second approach, based on the one-particle functions of the shell model, the Hamilton operator of the optical model, involving the isovector coupling term, is studied. This method should not be confused with the shell model of isobaric analog coincidences. Uses, advantages, and shortcomings of the two approaches are examined. (Review article, 17 references). (TTT)

50772 METHODS TO MEASURE INTERNAL CONVERSION COEFFFICIENTS AND ELECTRON CAPTURE TO POSITRON EMISSION RATIOS. (REVIEW). Tron, Lajos. ATOMKI (At. Kut. Intez.) Kozlem.; 12: No. 4, 195-211(Dec 1970). (In Hungarian).

Determination of the decay schemes and level parameters of radioactive nuclei requires measurement of internal conversion coefficients and electron-capture/positron-emission ratios. Both the internal conversion process and electron capture are accompanied by the emission of x radiation and Auger electrons. The measurement involves determination of the ratio of the probabilities for the two competing reactions. The techniques used for the determination of the conversion parameters include the absolute electron gamma method, the internal–external conversion method, the peak to Auger spectrum method, the peak to alpha spectrum method, the absolute beta–gamma method, the angular correlation method, and the sum peak method. The techniques used to determine the EC/β^+ ratio have an accuracy ranging from 5 to 50%; comparison with the theory requires an accuracy of better than 1%. Internal sources must be used to reach that level. Semiconductor detectors might be of interest for this purpose to carry out coincidence measurements, for which the low-resolution scintillation detectors cannot be used. (Review article, 50 references). (TTT)

50773 PRECOMPOUND PARTICLES IN $^{115}In(p,n)^{115}Sn$ REACTION; AND (p,n) REACTIONS IN GENERAL. Parthasaradhi, K.; Chandran, C. R.; Rao, V. Seshagiri; Ramamurty, S. (Andhra Univ., Waltair, India). pp 99-101 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay- Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

50774 ESTIMATE OF PRE-COMPOUND AND COMPOUND PARTICLES OF DECAY IN (p,n) REACTIONS ON ^{90}Zr AND ^{94}Zr TARGETS. Jhingan, M. L.; Kondaiah, E. (Tata Inst. of Fundamental Research, Bombay). pp 102-5 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

50775 HIGH RESOLUTION AND LOW COMPTON BACKGROUND OF THERMAL NEUTRON CAPTURE GAMMA RAYS. Tripathi, K. C. (National Physical Lab., New Delhi). pp 109-11 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

50776 CORRELATED EMISSION OF K X-RAYS FROM ^{252}Cf FISSION FRAGMENTS. Nadkarni, D. M.; Kapoor, S. S.; Ramamurthy, V. S.; Murthy, S. R. S. (Bhabha Atomic Research Centre, Trombay, India). pp 134-9 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

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50777 K-X RAY AND GAMMA-RAY DIRECTIONAL CORRELATION IN THE DECAY OF ^{186}Re. Rao, K. V. Ramana; Jagam, P.; Sastry, D. L. (Andhra Univ., Visakhapatnam, India). pp 140-4 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

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50778 DECAY OF ^{177m}Lu. Agnihotry, A. P.; Gopinathan, K. P.; Joshi, M. C. (Tata Inst. of Fundamental Research, Bombay). pp 148-53 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

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50779 INTERNAL CONVERSION MEASUREMENTS IN THE DECAY OF ^{169}Yb yields ^{169}Tm. Agnihotry, A. P.; Gopinathan, K. P.; Joshi, M. C. (Tata Inst. of Fundamental Research, Bombay). pp 154-8 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

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50780 LOW LYING LEVELS OF ^{123}Sb. Prasad, K. G.; Agnihotry, A. P.; Joshi, M. C. (Tata Inst. of Fundamental Research, Bombay). pp 159-64 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

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50781 NUCLEAR MATRIX ELEMENTS GOVERNING THE 437 keV BETA TRANSITION IN THE DECAY OF ^{125}Sb. Raju, M. L. Narasimha; Rao, V. Seshagiri; Sastry, D. L. (Andhra Univ., Waltair, India). pp 170-4 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

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50782 DECAY OF 6 MIN ^{152}Pm. Murty, K. S. N.; Pathak, B. P.; Mukherjee, S. K. (Saha Inst. of Nuclear Physics, Calcutta). pp 175-7 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

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50783 DECAY OF ^{91m_g}Mo TO THE LEVELS IN ^{91}Nb. Das, N. C.; Pathak, B. P.; Mukherjee, S. K. (Saha Inst. of Nuclear Physics, Calcutta). pp 178-81 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).
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50784 STRUCTURE OF THE 80 AND 364 keV STATES IN ^{131}Xe. Rama Murty, V. V.; Rama Rao, M. T.; Satyanarayana, G.; Lakshminarayana, V. (Andhra Univ., Waltair, India). pp 182-5 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).
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50785 STRUCTURE OF THE 57- and 351 keV STATES IN ^{143}Pr. Rama Murty, V. V.; Rama Rao, M. T.; Khayyoom, A.; Lakshminarayana, V. (Andhra Univ., Waltair, India). pp 186-90 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).
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50786 SYSTEMATICS OF THE SECOND MINIMUM FOR THE FISSIONING NUCLEI. Sood, D. K.; Sarma, N. (Bhabha Atomic Research Centre, Bombay). pp 198-203 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).
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50787 STATISTICAL RESONANCE OF ^{239}Pu. Sengupta, A.; Srikantiah, G. (Indian Inst. of Tech., Kanpur). pp 204-8 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).
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50788 PREDICTED MASS YIELDS FROM THE FISSION OF ^{238}U INDUCED BY NEUTRONS OF VARIOUS ENERGIES. Sarkar, Ratna (Saha Inst. of Nuclear Physics, Calcutta). pp 222-5 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).
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50789 LIQUID DROP MODEL CALCULATION OF THE TOTOL PROMPT GAMMA ENERGY, THE TOTAL KINETIC ENERGY, AND THE SCISSION POINT DEFORMATIONS OF FRAGMENT PAIRS FROM THE PROMPT NEUTRON NUMBERS. Mukherji, Shankar; Lal, K. B. (Indian Inst. of Tech., Kanpur). pp 226-30 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).
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50790 TOTAL FISSION CROSS SECTION MEASUREMENTS USING SOLID STATE TRACK DETECTORS. Iyer, R. H.; Sampathkumar, R. (Bhabha Atomic Research Centre, Trombay, India). pp 289-95 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).
From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208–(Vol.2).

50791 PARTICLE-CORE STATES IN ^{209}Pb. Rao, K. V. Chalapati (Saha Inst. of Nuclear Physics, Calcutta). pp 332-4 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).
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50792 LOW ENERGY SPECTRA OF THE ODD MASS ANTIMONY ISOTOPES. Sen, S.; Sinha, B. K. (Saha Inst. of Nuclear Physics, Calcutta). pp 349-55 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).
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50793 HIGHER ORDER EFFECTS IN SOME ALLOWED BETA TRANSITIONS FROM THE DECAY OF ^{134}Ce AND ^{125}Sb. Dahiya, H. S.; Singh, B. P. (Univ. of Roorkee, India). pp 387-90 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).
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50794 NUCLEAR TRANSITIONS IN ^{133}Cs FROM THE DECAY OF ^{133}Ba. Pande, U. S.; Singh, B. P. (Univ. of Roorkee, India). pp 391-5 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).
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50795 TRIPLE GAMMA CASCADE STUDIES IN ^{182}W FROM THE DECAY OF ^{182}Ta. Pande, U. S.; Singh, B. P. (Univ. of Roorkee, India). pp 396-9 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).
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50796 LEVEL SCHEME OF ^{152}Gd. Dasmahapatra, B. K. (Saha Inst. of Nuclear Physics, Calcutta). pp 400-3 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).
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50797 DECAY OF ^{124}Sb. Sud, S. P.; Suri, K. K.; Trehan, P. N. (Panjab Univ., Chandigarh, India). pp 415-18 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).
From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208–(Vol.2).

50798 DECAY OF ^{134}Cs AND ^{192}Ir. Sud, S. P.; Suri, K. K.; Mangal, P. C.; Trehan, P. N. (Panjab Univ., Chandigarh, India). pp 419-21 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).
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50799 GAMMA–GAMMA DIRECTIONAL CORRELATIONS ^{110}Cd. Sud, S. P.; Mangal, P. C.; Trehan, P. N. (Panjab Univ., Chandigarh, India). pp 422-5 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).
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50800 BETA GROUPS OF ^{99}Mo. Nagarajan, T.; Ravindranath, M.; Reddy, K. V. (Andhra Univ., Waltair, India). pp 426-8 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).
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Nuclear Theory

Refer also to abstracts 48969, 48982, 50273, 50646, 50647, 50663, 50685, 50687, and 50769.

50801 (CEA-N-1455) COUPLING OF NONPOLARIZED SPINS. Martinot, M. (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). 24 May 1971. 28p. (In French). Dep. NTIS (U. S. Sales Only).
The probability distribution of the J spin resulting from the coupling of N nonpolarized J spins is calculated exactly. The divergences from the limit distribution (N large) are examined. (France)

50802 (CONF-690732, pp 10.1-10) ISOSPIN IN NUCLEAR PHYSICS. Venter, R. H. (Atomic Energy Board, Pretoria (South Africa)). (In Dutch).

From fourth seminar on theoretical physics; Johannesburg, South Africa (7 Jul 1969).

Isospin is defined and discussion is given on isospin in nuclei, isospin and Hartree–Fock theory, isospin and proton single-particle states, and isospin and dipole states. (C.E.S.)

50803 (CONF-690732, pp 11,1-8) ISOSPIN EFFECTS IN DIPOLE EXCITATIONS. Fourie, P. du T. (Atomic Energy Board, Pretoria (South Africa)). (In Dutch).

From fourth seminar on theoretical physics; Johannesburg, South Africa (7 Jul 1969).

Topics discussed include isospin coupling, isospin matrix elements, angular momentum coupling, and numerical evaluation of matrix elements. (C.E.S.)

50804 (CONF-691208–(Vol.2)) PROCEEDINGS OF THE NUCLEAR PHYSICS AND SOLID STATE PHYSICS SYMPOSIUM, UNIVERSITY OF ROORKEE, DECEMBER 28–31, 1969. VOLUME II. NUCLEAR PHYSICS (CONTRIBUTED PAPERS). (Department of Atomic Energy, Bombay (India). Physics Committee). 1969. 452p.

Ninety-seven of the papers in this volume are listed by title in NSA; another one is outside the subject scope of NSA. (R.W.R.)

For abstracts of individual papers see: 48948, 48949, 48987–48990, 49713, 49727, 49750–49753, 49879, 49880, 49893, 49968–49971, 50160, 50623, 50624, 50635, 50636, 50658–50665, 50702–50715, 50773–50800, and 50853–50875.

50805 (JINR–E4-5925) EQUILIBRIUM PAIRING IN SOME SPHERICAL NUCLEI. Bal'butsev, E. B.; Bochnacki, Z. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 6p. Dep. NTIS (U. S. Sales Only).

Equilibrium pairing energy gaps for nuclei with $42 < Z < 56$ and $52 < N < 58$, $68 < N < 88$ are calculated by the total energy minimum method. The results are compared with the experimental odd-even mass differences. (auth)

50806 (JINR–E4-5992) NOTE ON THE GARTENHAUS–SCHWARTZ TRANSFORMATION. Palumbo, F. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 8p. Dep. NTIS (U. S. Sales Only).

It is shown that the Gartenhaus–Schwartz transformation cannot eliminate spurious effects in shell-model calculations. (auth)

50807 (JINR–P-4-5927) CORRELATION OF IDENTICAL PARTICLES EMITTED BY HIGHLY EXCITED NUCLEI. Kopylov, G. I.; Podgoretskii, M. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1971. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

The energy and angular correlations of neutrons evaporated by highly excited nuclei are studied. (auth)

50808 (JINR–P4-5863) ON THE REACTIONS (d,p) ON DEFORMED NUCLEI. Schulz, H.; Wiebicke, H. J.; Gareev, F. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). Jun 1971. 25p. (In Russian). Dep. NTIS (U. S. Sales Only).

The coupled-channel Born approximation (CCBA) is applied to the description of the deuteron stripping on ^{24}Mg and ^{176}Yb using deformed bound state functions which are expanded in terms of Sturmian functions. The optical and deformation parameters are adjusted by coupled-channel calculation from the elastic and inelastic scattering data. Such extended CCBA calculations are found to be important in many instances. (auth)

50809 (ORNL–4687) INSTRUCTIONS FOR THE OPERATION OF THE PROGRAM PACKAGE PICA, AN INTRANUCLEAR-CASCADE CALCULATION FOR HIGH-ENERGY (30 TO 400 MeV) PHOTON-INDUCED NUCLEAR REACTIONS. Gabriel, T. A.; Guthrie, M. P.; Hermann, O. W. (Oak Ridge National Lab., Tenn.). Sep 1971. Contract W-7405-eng-26. 44p. Dep. NTIS.

Operating instructions for the program package PICA, which calculates the differential particle spectra and distribution of residual nuclei following high-energy photon-nucleus collisions, are given. The photon energy range in which the calculations are applicable is $30 \gtrsim E_\gamma \gtrsim 400$ MeV. All target nuclei with mass numbers >4 are possible; however, the calculations have more validity with mass numbers ≳10. The program can accommodate incident monoenergetic photons as well as several types of photon spectra. The program is written in FORTRAN IV for the IBM 360/75 and IBM 360/91 computers. Input and output for a sample problem are given. (auth)

50810 (ORO–3765-33) BRUECKNER–HARTREE–FOCK CALCULATIONS OF THE DEFORMED NUCLEI, ^{12}C AND ^{20}Ne. Technical Report No. 71-124. Reid, Neal E.; Stephenson, G. J. Jr.; Banerjee, Manoj K. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Jun 1971. 33p. Dep. NTIS.

A Brueckner–Hartree–Fock calculation of the deformed nuclei ^{12}O and ^{20}Ne becomes possible with the use of a density-dependent effective interaction to produce effective G-matrix elements. An average density approximation is employed. The inclusion of the rearrangement energy in the calculation leads to an improved estimate of the binding energies. The calculation is done in the matrix representation with deformed Cartesian oscillator functions as a basis. The effects of mixing deformed major shells are compared to the mixing implicit in the Nilsson model. (auth)

50811 (ORO–3992-47) ABOUT CALCULATING (n, 2n): REACTIONS AMPLITUDES ON HEAVY NUCLEI. Olkovsky, V. S.; Yezhov, S. N. (Kiev State Univ. (Ukrainian S,S,R,)); Recami, E. (Texas Univ., Austin. Center for Particle Theory. Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). [1970]. 11p. (CPT–97; AEC–47). Dep. NTIS.

In this preliminary note, the authors put forward a method for solving the problem of coherent (n,2n) knock-out on heavy nuclei, at low energies, valid in the approximation of infinite-mass nuclei. For this, the equation by Faddeev or by Baz et. al. is shown to be unnecessary, due to the absence of 2n bound states. One starts from a "Gell–Mann and Goldberger" equation, whose inhomogeneous term is the T-matrix element in the DWBA. It is possible to expand the total wave-function (multiplied by the potential V_{12} between the two neutrons) on a complete discrete set of vectors (e.g. the isotropic tridimensional harmonic-oscillator eigenfunctions). Then, an infinite system of equations is obtained, which may be approximated to a finite system, with any degree of accuracy, as the previous expansion can be shown to converge. The problem is thus reduced to solving an algebraic instead of an integral system of equations. Further comments are made on the rescattering contribution. (auth)

50812 $\Delta N = 2$ COUPLING BETWEEN ONE-PARTICLE ORBITALS IN RARE-EARTH NUCLEI. Kanestroem, I. (Univ. of Oslo); Tjoem, P. O.; Bang, J. Nucl. Phys.; A164: 664-72(1971).

One-particle transfer reactions have been extensively studied for nuclei in the rare-earth region. The experiments show a considerable mixing between certain single-particle states which originate from different major shells. It is shown that the strength of coupling depends very strongly on the hexadecapole deformation of the Woods–Saxon potential. (auth)

50813 STATISTICAL-MODEL CALCULATIONS OF (n,p) CROSS SECTIONS USING SHELL-INDEPENDENT PARAMETERS. Pai, H. L. (Carleton Univ., Ottawa); Clarke, R. L.; Cross, W. G. Nucl. Phys.; A164: 526-44(1971).

Cross sections for first proton emission following 14 MeV neutron bombardment are derived from published experimental results, for 55 nuclei from ^{32}S to ^{98}Mo. These are compared with several statistical-model calculations to test for the effects of shells and pairing on level densities. In the conventional derivation, the level densities that control statistical proton emission depend on the (n,p) Q-value, the pairing energy and a shell-dependent parameter a. We obtain better agreement between theory and experiment by using instead an effective Q-value, derived from a semi-empirical mass formula whose parameters are smooth functions of mass number and free of fluctuations near closed shells. The level density parameter a is also taken to be shell-independent. For these smoothed parameters the r.m.s. error between theory and experiment is 24%, for cross sections greater than 10 mb. All attempts to introduce shell and pairing energies explicitly gave poorer agreement. (auth)

50814 DIAGRAMMATIC METHOD OF THE PARTICLE-VIBRATION COUPLING MODEL. II. APPLICATION TO CONVERGENCE AND SELF-ENERGY PROBLEMS IN ^{201}Tl. Paar, V. (Univ. of Copenhagen. Inst. Ruder Boskovic, Zagreb). Nucl. Phys.; A164: 593-611(1971).

Diagrams describing a system of a single-particle (hole) coupled to a quadrupole vibrator are systematically treated. Comparison between the results of a diagonalization and perturbation approach is made on the example of ^{201}Tl, with special emphasis on the self-energy problem. It is seen that the self-energy diagrams represent the main "diverging" contributions but their effect can be incorporated in the renormalization of the coupling strength. In the latter case, single-particle energies should be taken directly from experiment. The expressions for reduced matrix elements of the E2 operator from diagrams up to the third order simply give the behavior of quadrupole moments and B(E2) values in terms of the phonon energy and the single-particle configurations involved. (auth)

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50815 GENERALIZED SENIORITY AND STRUCTURE OF SEMI-MAGIC NUCLEI. Talmi, Igal (Weizmann Inst. of Science, Rehovot, Israel). Nucl. Phys.; A172: No. 1, 1-24(1971).

Nuclei with either protons or neutrons in closed shells are considered. States in which a pair of nucleons with $J = 0$ is distributed with unequal amplitudes over several j-orbits are considered. Conditions are given under which states with definite numbers of such pairs are eigenstates of the shell-model Hamiltonian. It is shown that these conditions imply binding energies of even nuclei which have linear and quadratic terms in the nucleon number. It is shown that these conditions are satisfied by effective Hamiltonians constructed for the Ni isotopes. Also pseudonium nuclei seem to fall into this category. The problem is investigated whether a linear and quadratic dependence of ground states energies implies zero generalized seniority for these states. Finally, states with generalized seniority $v = 1$ and $v = 2$ are considered. It is shown that if the latter states are eigenstates, a constant separation between the ground state and $v = 2$ states, independent of the number of pairs, follows. (auth)

50816 BLOCKING EFFECT IN THE NUCLEAR PAIRING THEORY: AN APPLICATION TO THE Sn ISOTOPES. Lee, H. C. (Atomic Energy of Canada Ltd., Chalk River, Ont.); Hara, K. Phys. Rev., C; 3: 325-8(Jan 1971).

The effect of blocking, for odd systems, is included in the gap equations of the nuclear pairing theory for a general two-body interaction. These equations are applied to calculate the one-quasiparticle low-energy spectra, the neutron separation energies, and the "odd-even mass differences" for the Sn isotopes. The apparent inflation of the effective pairing strengths in calculations in which the blocking effect is ignored is pointed out. (auth)

50817 MICROSCOPIC AND MACROSCOPIC DESCRIPTIONS OF GAMMA VIBRATION OF NUCLEI AT EQUILIBRIUM AND SADDLE POINT. Zielinska-Pfabe, M. (Inst. of Nuclear Research, Warsaw). Acta Phys. Pol.; B2: No. 2-3, 207-19(Apr-Jun 1971).

The gamma-vibrational parameters B_γ, C_γ and the energy E_γ of the gamma-vibrational state of the deformed nuclei are calculated as functions of the ϵ deformation in the whole region between the equilibrium and the saddle point. Both the microscopic and macroscopic descriptions are used. The following result is obtained: when ϵ increases from its equilibrium value to the saddle point, the nucleus begins to be more stiff with respect to the gamma vibration. (auth)

50818 DISPERSIVE EFFECTS IN HIGH-ENERGY ELASTIC ELECTRON–NUCLEUS SCATTERING AND NUCLEAR CORRELATIONS. Brown, W. D.; Kujawski, E. (Univ. of Maryland, College Park). Ann. Phys. (N. Y.); 64: No. 2, 573-98(1 Jun 1971).

The effects of virtual nuclear excitations in high-energy elastic electron–nucleus scattering are analyzed in a self-consistent manner. The scattering is described by an infinite system of coupled equations, which is solved in the semiclassical approximation. The resulting scattering amplitude is explicitly expressed in terms of the one- and two-body densities. The dispersion corrections are then directly related to the nucleon–nucleon correlations. To investigate the above ideas, the elastic scattering of 420-MeV and 840-MeV electrons by ^{16}O and ^{208}Pb is studied. The dispersive effects are most pronounced in the diffraction minima and small elsewhere, slightly energy and momentum-transfer dependent, and unlikely to be reproducible by changes in the charge density. Even if dispersion corrections were experimentally measurable, It would still be extremely difficult to extract from them information about dynamical short-range correlations because the short-range correlations are entangled with the Pauli correlations, self-correlations, and the differences in excited states. It is also shown that the elastic scattering may be obtained by solving a pair of coupled equations or a simple Dirac equation with an effective optical potential, and the above approaches are critically compared. (auth)

50819 SHELL CORRECTION IN THE INDEPENDENT-PARTICLE MODEL. Bhaduri, R. K.; Ross, C. K. (McMaster Univ., Hamilton, Ont.). Phys. Rev. Lett.; 27: No. 9, 606-9 (30 Aug 1971).

A method for obtaining a semiclassical expression for the single-particle density of states from the partition-function approach is formulated. In some simple solvable models, the semi-intuitive Strutinskii prescription is demonstrated to yield essentially identical results for shell correction and the proposed semiclassical procedure. This gives us greater confidence in the Strutinskii method. (auth)

50820 OFF-ENERGY-SHELL CONTINUATION OF THE TWO-NUCLEON TRANSITION MATRIX IN THE PRESENCE OF TENSOR FORCES. Sauer, P. U. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Nucl. Phys.; A170: No. 3, 497-512(1971).

For a coupled partial wave with a bound state, the entire T matrix is determined by the bound-state energy and wave function, the on-shell mixing parameter, and a real symmetric matrix function $\sigma(k_2\alpha_2, k_1\alpha_1)$ of the continuous momentum variables k and the discrete eigenchannel labels α. The on-shell part of σ is given by the eigenphases; the arbitrariness of the T matrix is the off-shell continuation of this phase-shift matrix $\sigma(k\alpha_2, k\alpha_1)$ into two dimensions. Three possible techniques are suggested to go from σ to the entire T matrix. This construction procedure for T avoids the usual complications of a potential fit. (auth)

50821 PAULI PRINCIPLE FOR REACTIONS WITH LIGHT NUCLEI. Zaikin, D. A. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Nucl. Phys.; A170: No. 3, 584-92(1971).

Effects of the Pauli principle in reactions with light nuclei are considered in the framework of the generator coordinate method. It is shown how the Pauli principle reduces the space of wave functions describing a certain channel of the reaction. Such a reduction is studied for all the physical cases of two colliding 0s fragments. (auth)

50822 TENSOR FORCE IN NUCLEAR SATURATION. Afnan, I. R.; Clement, David M.; Serduke, Franklin J. D. (Univ. of California, Davis). Nucl. Phys.; A170: No. 3, 625-48(1971).

One-term separable potentials in the $^3S-^3D$ channel are constructed that fit the following low-energy nucleon–nucleon data: the triplet effective range and scattering length and deuteron binding energy and quadrupole moment. They also yield $^3D_1$ phase shifts that have the correct sign. These potentials differ, however, in the amount of deuteron D-state probability, P_D, which they predict, where P_D ranges from 1% to 9%. Binding-energy calculations of infinite nuclear matter and ^4He are performed in order to test the effect of the tensor force on nuclear saturation properties. It is found that the larger the D-state probability, the smaller the energy per particle and saturation density. Detailed comparisons with local potentials in nuclear matter are also presented. In nuclear matter no single-particle potential in intermediate states is used; in ^4He, $U(r) = \frac{1}{2}M\omega^2r^2 - f\hbar\omega$, where f is varied such that the absolute value of the diagram with a single potential insertion in a particle line is minimized. It is found in ^4He that $f = 0.75$ and that this result is almost independent of both the potential employed and of $\hbar\omega$. Furthermore, for $0 \leq f \leq 1.5$, the total energy is independent of f. (auth)

50823 THEORY OF COULOMB DECAY IN REACTIONS BETWEEN COMPLEX NUCLEI. Grabovskii, Ya. (Inst. of Nuclear Physics, Krakow); Kalinkin, B. H. Acta Phys. Pol.; B2: No. 2-3, 225-33(Apr-Jun 1971). (In Russian).

The process of Coulomb decay in reactions between complex nuclei is studied. Investigations were made with account taken of the unadiabatic character of the collision, and also of the possibility of disintegration of the nucleus during the collision itself. The problems resulting from the consideration of this effect are also considered. (auth)

50824 COULOMB DISTORTION EFFECTS OF COLLIDING NUCLEI. Grabovskii, Ya. (Inst. of Nuclear Physics, Krakow); Kalinkin, B. H.; Martynov, V. I. Acta Phys. Pol.; B2: No. 2-3, 235-44(Apr-Jun 1971). (In Russian).

The dynamic distortion of colliding particles in the near-barrier energy range conditioned by their Coulomb interaction is considered. In contradistinction to the usually assumed condition of quasi-static collision, this work takes account of quantum effects and their effect on the height of the Coulomb barrier. Their role in exchange reactions is also considered. (auth)

50825 CALCULATIONS OF MESONIC CONTRIBUTIONS TO (γ,n) REACTIONS. Andersson, G.; Forkman, B.; Friberg, B. (Univ. of Lund, Sweden. Lund Inst. of Tech., Sweden). Nucl. Phys.; A171: No. 3, 529-50(1971).

A detailed analytical calculation of the (γ,n) cross section in the energy region 150 to 950 MeV has been performed, taking the contributions of both single and double pion photoproduction into account. The result is in good agreement with experimental measurements. (auth)

50826 OPTICAL MODEL PARAMETERS CALCULATED FROM DIFFERENT NUCLEON–NUCLEON PHASE SHIFTS. Zohni, O. (ICTP, Trieste, Italy); Hussein, H. M. Nucl. Phys.; A171: No. 3, 522-8(1971).

Optical-model parameters for elastic high-energy proton scattering are evaluated using the Kerman–McManus–Thaler theory. Different nucleon–nucleon phase shifts are used, and the results are indicative of essentially similar results. In contrast to the phenomenologically determined parameters of Satchler and Haybron, the calculated parameters are consistent with the "nature" of the optical model potential. (auth)

50827 THEORETICAL STUDIES OF NUCLEAR COLLISION PROCESSES OF DEFORMED NUCLEI. Rasmussen, John O.; Sugaware-Tanabe, Kazuko (Yale Univ., New Haven). Nucl. Phys.; A171: No. 3, 497-521(1971).

A new formulation for elastic, rotational inelastic, and compound nucleus cross sections for strongly absorbed projectiles on deformed nuclei is developed. The real part of the nuclear potential is characterized by ordinary optical model parameters and the barrier at all angles on the nuclear surface is approximated by an inverted parabolic barrier. The transmission of this barrier as given by the Hill–Wheeler formula is used, avoiding radial integration of the wave equation. Alpha scattering data on samarium are fitted by the calculations, and predictions for various heavier ion reactions are presented. In particular, the ^{40}Ar on ^{235}U shows a significantly lower reaction threshold due to the static deformation of uranium. (auth)

50828 CALCULATION OF sd SHELL SPECTRA IN A = 18 NUCLEI WITH HARTREE–FOCK INTERACTIONS. Nguyen, Quang-Hoc; Pearson, J. M. (Univ. of Montreal). Nucl. Phys.; A164: 631-40(1971).

Spectroscopic calculations on A = 18 nuclei are performed with the effective interactions of Nestor et al., and of Saunier and Pearson, which have been devised primarily for use in Hartree–Fock. Reasonable spectra are obtained provided (a) the interactions are renormalized and (b) the even-state scattering properties are correct. (auth)

50829 CORRELATION BETWEEN FISSION ISOMER HALF-LIVES AND LIQUID-DROP MODEL PARAMETERS. Metag, V.; Repnow, R.; von Brentano, P. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Phys.; A165: 289-304(1971).

A semiempirical systematics of known fission isomer half-lives is proposed. For doubly odd and odd-mass nuclei there seems to be a pronounced correlation between the half-lives and the liquid-drop model fissility parameter with an additional modulation due to the variation of shell effects with neutron number. For even nuclei the observed isomeric half-lives are nearly constant irrespective of Z and A. A model based on a simplified double-humped fission barrier is discussed which may account for the general trend of fission isomeric half-lives of doubly odd and odd-mass nuclei. Parameters are given which reproduce the observed half-lives. Excitation energies and fission barrier heights are compared with the predictions of the model. Other explanations are considered for isomers in doubly even nuclei which do not follow the systematics. (auth)

50830 COLLECTIVE POTENTIAL ENERGY SURFACES AND NUCLEAR STRUCTURE. Gneuss, Gotthard; Greiner, W Walter (Univ., Frankfurt am Main). Nucl. Phys.; A171: No. 3, 449-79(1971).

The collective potential energy surfaces of the doubly even nuclei can be obtained either by calculation from microscopical models or directly from the experimental low-energy spectra. In both cases it is necessary to have a method for the calculation of nuclear spectra in arbitrarily shaped potential energy surfaces. Such a method is obtained by the diagonalization of the collective Hamiltonian in the basis of the five-dimensional quadrupole oscillator. The method is described in detail. Its convergence and accuracy are tested and its efficiency is demonstrated. Some studies about the anharmonicities of the kinetic energy are also presented. (auth)

50831 ANGULAR MOMENTUM DEPENDENCE OF THE OPTICAL POTENTIAL IN HEAVY-ION SCATTERING. Helling, G.; Scheid, W.; Greiner, W. (Univ., Frankfurt am Main). Phys. Lett.; 36B: No. 2, 64-7(23 Aug 1971).

An imaginary potential for elastic heavy-ion scattering is derived from the transition probability into inelastic channels. Angular momentum dependence of the imaginary potential arises from nuclear level density of the compound system and is compatible with the experimental ^{16}O–^{16}O cross section. (auth)

50832 GENERALIZED CORE-POLARIZATION MODEL FOR INELASTIC SCATTERING. Satchler, G. R. (Oak Ridge National Lab., Tenn.); Love, W. G. Nucl. Phys.; A172: No. 3, 449-68 (1971).

A deformed-potential model for including core-polarization effects in microscopic descriptions of inelastic scattering has been generalized to include spin and isospin oscillations. It is shown how these effects may be related to data for inhibited or enhanced electromagnetic and β-transitions. (auth)

50833 TREATMENT OF EXPERIMENTAL RESOLUTION. Esch, L. J. (General Electric Co., Schenectady, N. Y.); Bischoff, F. G.; Moore, W. E.; Yeater, M. L. Contract W-31-109-eng-52. Nucl. Instrum. Methods; 95: No. 1, 125-30(1971).

A method is described for imposing conditions of experimental resolution broadening on a theoretical model to be compared with data obtained in time-of-flight experiments. The method is illustrated by an example based on a neutron inelastic scattering experiment. Functions describing the actual time and velocity distributions in the incident beam are determined empirically. These functions are convolved with cross sections derived from a theoretical model for scattering by the use of Monte Carlo techniques. The Monte Carlo procedure also takes into account the contribution to the resolution function of path length uncertainties and finite analyzer time channel widths. (auth)

50834 INFLUENCE OF SHORT-RANGE CORRELATIONS ON NUCLEON EMISSION IN ELECTRON SCATTERING BY NUCLEI. Malecki, A. (Inst. of Nuclear Physics, Krakow); Picchi, P. Phys. Lett.; 36B: No. 2, 61-3(23 Aug 1971).

The nucleon emission induced by high-energy electrons is analyzed in three experimental situations: electron–proton coincidence and single detection of electron or proton. The coincidence and proton detection experiments are recommended as sensible tools for studying the nuclear correlations. (auth)

50835 ANHARMONIC EFFECTS IN SPHERICAL NUCLEI. Almoney, S. R.; Borse, G. J. (Lehigh Univ., Bethlehem, Pa. Nucl. Phys.; A171: No. 3, 660-72(1971).

A microscopic model for spherical nuclei is presented which produces anharmonic admixtures of the quasiparticle random-phase phonon solutions. The anharmonic effects, such as non-zero static quadrupole moments, Q_2, and crossover transition rates, are the results of retaining quasiparticle scattering terms in the pairing-plus-quadrupole Hamiltonian. The calculations using both neutrons and protons show that the single quasiparticle terms are usually significant since even small admixtures result in values for Q_2 that are larger than 0.1 e · b. The results of the calculations for the B(E2) and the Q_2 values are presented for most spherical nuclei. (auth)

50836 INELASTIC SCATTERING OF FAST ELECTRONS BY LIGHT NUCLEI WITH THE EXPULSION OF CLUSTERS. Tartakovskii, V. K.; Ismatov, E. I.; Pavlov, A. B. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 1, 62-6(1971). (In Russian).

The inelastic scattering of fast electrons by light nuclei was investigated, giving particular attention to the expulsion of "clusters"—groups of nucleons bound in the S-shell. The cross section of the process was calculated with the first Born approximation. Each nucleon was considered as originating in the outer electron field, described by the Moller transition potential. After developing the pertinent equations, the authors apply them to the fast electron scattering cross section by ^{6}Li, with the expulsion of two nucleons with the formation of a deuteron. (K.S.W.)

50837 SECOND-CLASS CURRENTS AND EXPERIMENTAL NUCLEAR MIRROR ASYMMETRY. Lipkin, Harry J. (Weizmann Inst. of Science, Rehovot, Israel). Phys. Rev. Lett.; 27: No. 7, 432-4(16 Aug 1971).

Weak-current effects can explain the experimentally observed mirror asymmetry in nuclear β decays despite the absence of energy dependence predicted by a naive model for second-class currents. Meson exchange with $\omega \rightarrow \pi$ decay in the nucleus can result either from second-class currents or electromagnetic $\omega\rho$ mixing and can be enhanced by a factor A due to nuclear coherence. (auth)

50838 NEW METHOD FOR THE ANGULAR-MOMENTUM PROJECTION. Ullah, Nazakat (Tata Inst. of Fundamental Research, Bombay). Phys. Rev. Lett.; 27: No. 7, 439-42(16 Aug 1971).

A new method is proposed to carry out the angular-momentum projection from a given intrinsic wave function. The method is based on the construction of a generating function for the various powers of the step-up and step-down operators and a property of Lie algebra. It has the advantage that no integrations over the Euler angles have to be performed. (auth)

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50839 SHAPE OF THE ISLAND OF SUPERHEAVY NUCLEI. Bolsterli, M.; Fiset, E. O.; Nix, J. R.; Norton, J. L. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett.; 27: No. 10, 681-4(6 Sep 1971).

The shape of the island of superheavy nuclei is calculated on the basis of the Strutinsky shell-correction method applied to realistic diffuse-surface potentials. With respect to spontaneous fission, the island is a mountain ridge extending from 114 protons to about 124 protons. The descent from the mountain down to the sea of instability is rather gentle for decreasing neutron numbers below 184, but is more rapid on the other three sides. (auth)

50840 PROJECTED SPECTRA FROM A DEFORMED CORRELATED INTRINSIC STATE. Ullah, N.; Gupta, K. K. (Tata Inst. of Fundamental Research, Bombay). Phys. Lett.; 36B: No. 3, 196-8(6 Sep 1971).

It is argued that the residual interaction being relatively of long range, should produce Random Phase Approximation (RPA) type of correlations in the Hartree-Fock (HF) intrinsic state. A model is described to take these correlations into account in the intrinsic state. A comparison of the projected spectra from this state with the exact shell model diagonalization for a model problem bears out this point. An application of the model in distinguishing two almost degenerate HF solutions for the 2s-1d shell nuclei is mentioned. (auth)

50841 PAIRING FORCE, INTRINSIC QUADRUPOLE MOMENT AND MOMENT OF INERTIA. Chandra, H.; Rustgi, M. (State Univ. of New York, Buffalo). Phys. Lett.; 36B: No. 3, 185-8(6 Sep 1971).

Contrary to the usual belief, it is pointed out that though the presence of the pairing force always decreases the Cranking model value of the moment of inertia compared to its Hartree–Fock value, it is necessarily not true for the quadrupole moment. (auth)

50842 NUCLEAR-SOFTNESS MODEL OF GROUND-STATE BANDS IN EVEN–EVEN NUCLEI. Gupta, R. K. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Lett.; 36B: No. 3, 173-8(6 Sep 1971).

A nuclear-softness (NS) model for the energy levels of the ground-state bands in even-even nuclei is proposed by treating the variation of the moment of inertia with J in a more generalized manner. The model yields good fits to the observed spectra of all the even-even nuclei, including even the nuclei having only two particles or holes with respect to a closed shell. The idea of considering only the first-order nuclear softness with additional configuration-mixing effects in the ground state has also been tested. (auth)

50843 SIMPLE MODEL FOR NUCLEAR ROTATION AT HIGH ANGULAR MOMENTA. Krumlinde, J.; Szymanski, Z. (Lund Inst. of Tech., Sweden). Phys. Lett.; 36B: No. 3, 157-60(6 Sep 1971).

A simple solvable model of particles coupled to a rotor is introduced. The solutions illustrate some properties of the nucleus rotating with high angular momentum. (auth)

50844 DYNAMICAL DISTORTION OF NUCLEI IN HEAVY ION REACTIONS. Jensen, A. S. (Chalk River Nuclear Labs., Ont.); Wong, C. Y. Nucl. Phys.; A171: No. 1, 1-15(1971).

The dynamics of the deformation is considered for two spherical nuclei in head-on collisions. Both the Coulomb interaction and the nuclear interaction are taken into account. The interaction barrier, above which the two nuclei collapse together, changes as a result of dynamical distortions. This change is positive or negative, depending on the combination of target and projectile. The magnitude of the change is, however, only a few percent, even in the most favorable case considered. From the studies of the dependence of the excitation energy on collision energies one observes an interesting interference between the Coulomb and the nuclear interaction for different multipoles as the interaction barrier is approached. The studies of the dynamics of distortion also make it possible to trace the history of two nuclei moving toward fusion until a neck begins to appear. (auth)

50845 QUADRUPOLE EFFECT OF POLARIZED NUCLEI ON ELASTIC SCATTERING OF CHARGED PARTICLES. Kim, Y. N. (Texas Tech. Univ., Lubbock). Phys. Rev., C; 4: No. 2, 650-1 (Aug 1971).

The partial-wave calculation of the quadrupole effect of polarized target nuclei on the elastic scattering of charged particles at low incident energies is carried out. It is shown that the second-order quadrupole effect can easily dominate the first-order effect. The case in which muons are projectiles is exceptional. (auth)

50846 POTENTIAL SCATTERING AND SPECTROSCOPIC FACTORS IN R-MATRIX THEORY. Westin, G. D.; Adams, J. L. (Ohio Univ., Athens). Phys. Rev., C; 4: No. 2, 363-76(Aug 1971).

The R-matrix theory of nuclear scattering is used to consider the meaning of spectroscopic factors for unbound states. Potential scattering is explicitly calculated by constructing an R function that is equivalent to the potential. The compound effects are then parametrized in the usual R-matrix fashion with the spectroscopic factors being explicitly included as parameters. The spectroscopic factors are found by fitting data. The spectroscopic factors are very sensitive to the choice of the various resonance parameters, and the validity of spectroscopic factors as a meaningful quantity for unbound states is discussed in the light of several calculations. Several types of resonances found in the reactions $^{12}C(n,n)^{12}C$ and $^{16}O(n,n)^{16}O$ are considered; these include the cases of very narrow and very broad resonances and a double-resonance situation. (auth)

50847 DOUBLE-SCATTERING CORRECTIONS TO THE DISTORTED-WAVE IMPULSE APPROXIMATION. Haybron, R. M. (Cleveland State Univ.). Phys. Rev., C; 4: No. 2, 338-48(Aug 1971).

The distorted-wave impulse approximation for inelastic scattering of protons from nuclei is modified to include double-scattering contributions. The correction was cast in terms of directly measurable or phenomonological quantities to obviate the effects of specific nuclear models. Although the "exact" form of the correction is a complicated nonlocal operator in the space of the scattering proton, a simplified version of the correction is found which, along with finite-range corrections, gives remarkably good account of the strength of cross sections for inelastic scattering by ^{12}C at 45 and 100 MeV. (auth)

50848 CHARGE-EXCHANGE EFFECT ON THE EFFECTIVE NEUTRON–PROTON INTERACTION IN MIRROR NUCLEI. Basu, M. K.; Banerjee, D. (University Coll. of Science, Calcutta). Phys. Rev., C; 4: No. 2, 652-3(Aug 1971).

The systematics of the effective neutron–proton interactions in mirror nuclei is discussed. Magic- and submagic-number effects are clearly indicated. Behavior of the charge-exchange part of the effective neutron–proton interaction is shown. (auth)

50849 SECOND-CLASS CURRENTS IN NUCLEAR BETA DECAY. Kim, C. W.; Fulton, T. (Johns Hopkins Univ., Baltimore). Phys. Rev., C; 4: No. 2, 390-7(Aug 1971).

Expressions for the ratio of ft values for mirror β decays are given in the treatment of nuclei as elementary particles with emphasis on the effects of second-class currents. The results are compared with the corresponding ones in the usual impulse-approximation treatment with off-mass-shell and meson-exchange corrections. Theoretical implications of the data of Wilkinson and Alburger are examined. (auth)

50850 EFFECTIVE INTERACTION AND EFFECTIVE OPERATORS WITH HARD-CORE POTENTIALS. Palumbo, F. (CNEN, Rome. Univ., Rome). Phys. Rev., C; 4: No. 2, 327-37(Aug 1971).

The effective interaction with hard-core potentials is studied when both a correlated and an uncorrelated basis is used. While the use of a correlated basis leads to a series expansion that is uniquely defined to any order, the use of an uncorrelated basis leads to a series expansion that is not uniquely defined to any order, although the series can converge to a unique result. A method is given for evaluating this series perturbatively; this method is numerically simple and improves the accuracy of calculation of matrix elements of operators sensitive to the core region. It does not require the rearrangement of the graphs in ladder-type terms; the rearrangement can be done whenever it is convenient. The separation method and the reference-spectrum method are discussed in the light of the present method. (auth)

50851 TWO-NUCLEON T MATRIX HALF OFF THE ENERGY SHELL: A DIRECT APPROACH. Picker, H. S.; Redish, Edward F.; Stephenson, G. J. Jr. (Univ. of Maryland, College Park). Phys. Rev., C; 4: No. 2, 287-302(Aug 1971).

The T matrix half off the energy shell can be expressed in terms of the on-shell T matrix and the difference between the full scattering wave function and the phase-shifted free wave function. This representation allows one to investigate variations in the half-shell T matrix by means of a parametrization of the scattering wave function in the interaction region. Most of our knowledge of the physical constraints on that wave function may then be included. In particular, the arbitrariness remaining in the half-shell T matrix is studied under the following constraints: The on-shell

T matrix is given; a specific local potential acts beyond a certain radius; and the wave function is suppressed at short distances. Models of the $^1S_0$ two-nucleon half-shell T matrix are constructed. In a simple one-parameter model satisfying these constraints, the range of variation of the near off-shell behavior is displayed. (auth)

50852 APPROACH TO NUCLEAR THEORY INCLUDING SHELL-MODEL CONDITIONS AND PARTICLE CORRELATIONS. Agodi, A.; Baldo, M.; Catara, F. (Univ., Catina, Italy. INFN, Catania, Italy). Nucl. Phys.; A171: No. 1, 199-208(1971).

An approximate unified treatment of nuclear spectra and reactions is proposed which allows taking into account a large class of particle correlations in nuclei as well as the "shell-model" relationship of a selection of single-particle and single-hole states with the ground state of a closed-shell nucleus. Some preliminary results are reported on the point spectrum of the ^{16}O nucleus. (auth)

50853 OPTICAL POTENTIALS FOR ^{3}He AND TRITON. Mukherjee, S.; Satpathy, R. K.; Samaddar, S. K. (Saha Inst. of Nuclear Physics, Calcutta). pp 4-7 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28-31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

50854 POSSIBILITY OF FINDING THE α-CLUSTERING PROBABILITY FROM (n,α) AND (p,α) STUDIES. Chatterjee, M. L. (Saha Inst. of Nuclear Physics, Calcutta); Jurcevic, M. pp 21-5 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28-31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol. 2).

50855 PROJECTED HFB CALCULATIONS IN P-f SHELL NUCLEI. Parikh, Jyoti; Khadkikar, S.; Sandhyadevi, K.; Banerjee, B. pp 29-34 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28-31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

50856 SHELL MODEL CALCULATION OF π^--ABSORPTION RATE IN COMPLEX NUCLEI. Kaushal, R. S. (Indian Inst. of Tech., Kanpur). pp 41-6 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28-31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol. 2).

50857 ABSORPTION OF FREE PIONS FOLLOWED BY SINGLE-NUCLEON EMISSION. Kaushal, R. S.; Waghmare, Y. R. (Indian Inst. of Tech., Kanpur). pp 47-50 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28-31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

50858 SUITABLE OPTICAL MODEL PARAMETERS FOR EVALUATION OF NEUTRON CROSS SECTIONS BELOW 2 MeV. Sharma, H. C.; Nath, N. (Banaras Hindu Univ., India). pp 122-8 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28-31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

50859 STATISTICAL THEORY CALCULATIONS OF NEUTRON CAPTURE CROSS SECTIONS AT 200 keV. Chaubey, A. K.; Rajput, M. S.; Sehgal, M. L. (Aligarh Muslim Univ., India). pp 129-33 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28-31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

50860 FRAGMENT ANGULAR DISTRIBUTIONS IN THE FRAMEWORK OF A DOUBLE-HUMPED FISSION BARRIER. Ramamurthy, V. S.; Kapoor, S. S.; Kataria, S. K. (Bhabha Atomic Research Centre, Trombay, India). pp 191-7 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28-31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

50861 EXCITATION ENERGY OF A FERMI GAS IN THE (n,2n) CHANNEL. Chatterjee, Swapna (Saha Inst. of Nuclear Physics, Calcutta). pp 209-13 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28-31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

50862 CALCULATION OF THE STATISTICAL LEVEL DENSITY PARAMETER FROM THE RENORMALIZED FERMI GAS MODEL. Ghosh, S. K.; Chatterjee, S.; Chatterjee, A. (Saha Inst. of Nuclear Physics, Calcutta). pp 214-16 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28-31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

50863 ENERGY DISTRIBUTIONS IN PROMPT FISSION FRAGMENTS. Sarkar, Ratna; Chatterjee, Aparesh (Calcutta Univ. Saha Inst. of Nuclear Physics, Calcutta). pp 217-21 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28-31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

50864 PHENOMENOLOGICAL ALPHA-ALPHA POTENTIAL AND THE PROPERTIES OF NUCLEAR MATTER. Khanna, K. M. (Dibrugarh Univ., India); Das, G. B. L. pp 235-8 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28-31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

50865 NUCLEAR DISTORTION EFFECTS ON THE EMITTED PION IN PHOTO-PION REACTIONS. Devanathan, V. (Univ. of Madras). pp 239-41 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28-31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

50866 PAIRING VIBRATION MADE EASY. Pal, M. K. (Saha Inst. of Nuclear Physics, Calcutta). pp 321-3 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28-31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

50867 ROLE OF j^2 TERM IN NILSSON MODEL HAMILTONIAN. Mantri, A. N.; Sood, P. C. (Banaras Hindu Univ., India). pp 324-7 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28-31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

50868 E1 TRANSITION WITH N-MIXED NILSSON ORBITALS. Ramakrishna, G. (Saha Inst. of Nuclear Physics, Calcutta). pp 328-31 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28-31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

50869 BODY ROTATION OF DEFORMED NUCLEI. Gupta, Raj K. (Panjab Univ., Chandigarh, India). pp 335-9 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28-31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

50870 TWO-CENTRE ROTATIONAL-VIBRATIONAL MODEL WITH PHENOMENOLOGICAL POTENTIAL. Deshpande, V. K.; Prakash, V. R.; Bahal, B. M. (Indian Inst. of Tech., Kanpur). pp 340-4 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28-31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).

From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208-(Vol.2).

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50871 SINGLE PARTICLE CORE-COUPLING MODEL. Augusthy, A.; Sehgal, M. L. (Aligarh Muslim Univ., India). pp 358-62 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).
From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208–(Vol.2).

50872 COMPLEX ANGULAR MOMENTRUM METHODS IN THE STUDY OF NUCLEON–NUCLEUS ELASTIC SCATTERING. Satpathy, R. K. (Ravenshaw Coll., Cuttack, India); Shanta, R. pp 369-73 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).
From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208–(Vol.2).

50873 GENERALIZED HAMILTONIAN AND RESONANCE STRUCTURE FUNCTION. Dhar, J. L.; Shah, S. K. (M. S. Univ., Baroda, India). pp 374-8 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).
From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208–(Vol.2).

50874 DIFFERENTIAL EQUATION FOR LOGARITHMIC DERIVATIVE AND ITS APPLICATIONS. Gupta, S. K. (Tata Inst. of Fundamental Research, Bombay). pp 379-81 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).
From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208–(Vol.2).

50875 HELICITY OF ANTINEUTRINOS EMITTED BY NUCLEI. Palathingal, J. C. (Univ. of Michigan, Ann Arbor. Univ. of Cincinnati. Madras Christian Coll.). pp 382-5 of Proceedings of the Nuclear Physics and Solid State Physics Symposium, Univ. of Roorkee, December 28–31, 1969. Vol. II. Bombay; Dept. of Atomic Energy (1969).
From Nuclear physics and solid state physics symposium; Roorkee, India (28 Dec 1969). See CONF-691208–(Vol.2).

50876 TWO PARTICLE–TWO HOLE MIXING IN HARTREE–FOCK CALCULATIONS. Rabbat, J. A.; Do Dang, G. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Phys. Lett.; 35B: No. 6, 480-2(5 Jul 1971).

The constrained Hartree–Fock theory is used for studying the stability of the solutions against two-particle–two-hole excitations. Quadrupole and hexadecapole deformations are imposed on the Hartree–Fock equations to get the true energy minimum and the equilibrium shape. Energy corrections are calculated using second-order perturbations and complete diagonalization. Applications are made to the nuclei ^{20}Ne and ^{28}Si. (auth)

50877 SINGLE-PARTICLE MODEL FOR STRONGLY DEFORMED NUCLEI. Dickman, F. (Univ. of Copenhagen. Kernforschungszentrum, Karlsruhe, Ger.). Phys. Lett.; 35B: No. 6, 467-8(5 Jul 1971).

Several changes are proposed to the usual ansatz used with the two-center oscillator model; with these changes the fission of a nucleus from its ground-state deformation to the ground-state deformations of the fission fragments can be described in a continuous way. (R.W.R.)

50878 WBP MODEL STRIPPING CALCULATIONS WITH HAMADA–JOHNSTON WAVE FUNCTION. Pearson, C. A.; Covan, J. M.; Zissermann, D. (Univ. of Alabama, Brimingham). Phys. Lett.; 35B: No. 6, 461-3(5 Jul 1971).

The use of the Hamada–Johnston deuteron wave function in WBP-model calculations yields results that are essentially identical to the results of previously reported calculations with the Yamaguchi wave function. (auth)

50879 EFFECTS OF NUCLEAR SIZE AND CURVATURE OF SPIN–ORBIT SPLITTING. Stocker, W. (Univ., Munich). Phys. Lett.; 35B: No. 6, 472-4(5 Jul 1971).

The A-dependence of spin–orbit potentials and splittings following from two-body spin–orbit potentials is investigated by taking into account higher derivatives of the nuclear density. The specific curvature effects are shown to be small. (auth)

50880 MULTIPLE FISSION OF SUPERHEAVY NUCLEI. Fraser, R. (Univ., Frankfurt am Main); Grumann, J.; Greiner, W. Phys. Lett.; 35B: No. 6, 483-6(5 Jul 1971).

The stiffness parameters of superheavy nuclei for octupole deformations are calculated for all octupole modes. A considerable instability against a_{33} octupole deformations for oblate quadrupole shapes is found. The importance of this effect for ternary and binary fission is discussed. This effect supports the earlier suggestion [Z. Phys., 228: 371(1969)] that the oblate fission of superheavy nuclei is, in fact, the doorway to multiple fission. (auth)

REACTOR TECHNOLOGY

Commercial Power Reactors

50881 (JAERI–13484) JPDR-II PROJECT. Progress Report. No. 12 (Part 1). (Japan Atomic Energy Research Inst., Tokai). Feb 1969. 18p. NTIS (U. S. Sales Only).

The results of design, research, and development under JPDR-II project system covering the latter half-year of fiscal year 1967 (Oct. '67 Mar. '68) are presented. Part I includes: (1) Advances in design of JPDR-II; (2) Advances in research and development connected to JPDR-II; (3) Process of safety investigation by AEC; (4) Administration of JPDR-II project; (5) OECD Halden project. (auth) (Japan)

50882 (JAERI–13485) JPDR-II PROJECT. Progress Report, No. 12 (Part 2). (Japan Atomic Energy Research Inst., Tokai). Feb 1969. 189p. NTIS (U. S. Sales Only).

The results of design, research, and development under JPDR-II project system covering the latter half-year of fiscal year 1967 (Oct. '67 ~ Mar. '68) are presented. Part 2 describes: (1) Nuclear, thermal-hydraulic design; (2) Fuel assembly design; (3) Core internal structure design; (4) Plant design; (5) Analysis of safety and dynamic performance; (6) Reconstruction engineering; (7) Fuel development; (8) Thermal-hydraulic test; (9) Flow assembly test; (10) Computer control. (auth) (Japan)

50883 (JAERI–13510) CHANGES OF THERMAL SHOCK PARAMETER OF GRAPHITE IN THE TOKAI NUCLEAR POWER STATION. Honda, Toshio; Yoshida, Hiroshi; (and others) (Japan Atomic Energy Research Inst., Tokai). Apr 1969. 16p. NTIS (U. S. Sales Only).

Information on the thermal shock parameter of neutron irradiated graphite in the Tokai Nuclear Power Station is presented. The thermal shock parameter can be determined by determining each individual property of neutron irradiated graphite, elastic modulus, bending strength, thermal expansion coefficient, and thermal conductivity and combining them. The factors that affect the thermal shock parameter are also discussed. In applying these results to specific reactor conditions, the effects of graphite shape and heat transfer conditions can be estimated, but are too complex to calculate with any degree of certainty. (auth) (Japan)

50884 (JAERI–13534) CALCULATION OF THE CRUCIFORMED CONTROL ROD. 4. The Energy Dependency of the Logarithmic Deviative Condition and the Calculation of the Control Rod Worth. Takeda, Renzo; Takeuchi, Eiji (Japan Atomic Energy Research Inst., Tokai). Apr 1969. 36p. NTIS (U. S. Sales Only).

The energy dependency of the logarithmic deviative condition of an absorbing slab is investigated. With the presence of the strong absorber, the epithermal spectrum is made different from 1/E. Taking account of this fact in the calculation of the thermal group neutron source, the flux calculations are carried out rigorously in the treatment of the energy. These results are applied in the refinement of the design of control rod worth of JPDR-II, and comparisons are made with the worth obtained using 1/E spectrum in the epithermal region. (auth) (Japan)

50885 (JAERI–13548) PRESSURE DROP IN THE JPDR-TEST FUEL ASSEMBLY. Morishima, Atsuyoshi; Harayama, Yasuo; (and others) (Japan Atomic Energy Research Inst., Tokai). May 1969. 29p. NTIS (U. S. Sales Only).

Since a high-power density fuel assembly in the JPDR project was developed, designing a fuel-rod spacer has been one of the problems to be solved. The fuel assembly consists of fuel rods, tie-plates, and a few fuel-rod spacers. Among these, the fuel-rod spacer is one of the more important. Recently, the new types of fuel-rod spacers were developed for use in the high-power density fuel assemblies. The results of tests are described of the fuel-rod spacers at atmospheric pressure, room temperature and in single-phase turbulent flow in the FAT-1 loop. Some studies were also made on the hydraulic characteristics of the JPDR test fuel assembly. (auth) (Japan)

50886 (JAERI–13593) SUMMARIES REPORTED IN THE 2nd CONFERENCE ON JPDR-II PROJECT. (Japan Atomic Energy Research Inst., Tokai). Jun 1969. 74p. NTIS (U. S. Sales Only).

The summaries contained describe progress in the development on JPDR-II project during the three years since the 1st conference held on July 18, 1966. JPDR-II project consists of modifying the 12.5 MW(e) JPDR plant to provide forced circulation loops and a dump condenser system for the purpose of increasing the reactor power density for use as a high power density irradiation facility. The research and development works in the project consist of the following: (1) Core calculation, (2) Fuel assembly design, (3) Reactor internals design, (4) Plant design, (5) Safety analysis and reactor characteristics analysis, (6) Experimental program of fuel development and fuel irradiation, (7) In-core instrument development, (8) Experimental program of heat transfer, (9) Experimental program of fluid flow, (10) Computer control development. (auth) (Japan)

50887 (JAERI–13665) DESIGN OF JPDR-II EMERGENCY VENTILATION SYSTEM. Removal System of Radioactive Iodine From Flowing Steam-Air into the Atmosphere by Filter System Containing Impregnated Charcoals. Futamura, Yoshiaki; Suzuki, Hiroyoshi; (and others) (Japan Atomic Energy Research Inst., Tokai). Jul 1969. 44p. NTIS (U. S. Sales Only).

When fission product iodine is released into the air of reactor enclosure in M.C.A. or H.A. a generally small but often significant proportion of the iodine may exist as methyl iodide. Fission product iodine that will leak into the atmosphere leaks mainly through penetrations of enclosure. Fission product iodine leaks through penetrations of enclosure must be removed by the emergency ventilation system. The details of design of the emergency ventilation system and of main equipment which consists of a filter system and ventilation system are described. (auth) (Japan)

50888 (JAERI–13667) THERMAL AND HYDRAULIC CHARACTERISTIC CALCULATION IN THE JPDR CORE BY THE "JP-HYDRO" CODE COUPLED WITH THE MEASURED RESULTS. Ikeda, Hajime (Japan Atomic Energy Research Inst., Tokai). Aug 1969. 22p. NTIS (U. S. Sales Only).

Presented are thermal and hydraulic calculations in the JPDR core by the numerical code JP-Hydro in which input data and calculation boundarys are induced by the measurements of the Instrumented Fuel Assembly (IFA #3). By this calculation it is determined that the total recirculation flow and exit steam quality will be 2100 T/hr and 4.7%, respectively and the relation of the characteristic between the standard fuel and the IFA channel is clarified. (auth) (Japan)

50889 (JAERI-Memo–4327) A REFERENCE DESIGN OF PuO_2–UO_2 ASSEMBLY FOR JPDR-II CORE. Matsuura, Shojiro; Naito, Yoshitaka; Murakami, Kiyonobu (Japan Atomic Energy Research Inst., Tokyo). Jan 1971. 90p. (In Japanese). Dep. NTIS (U. S. Sales Only).

Performance tests on PuO_2–UO_2 fuel assemblies in JPDR-II core are planned to obtain necessary information for plutonium utilization in light water power reactors. A reference design study of the PuO_2–UO_2 fuel assembly to be used for the test has been performed. The plutonium enrichment of the fuel material under the same geometrical condition of the fuel assembly and the same design criterion to JPDR-II core with 26 wt % UO_2 fuel is calculated. The plutonium was assumed to contain 18 wt % of Pu-240. The parameter survey shows that the PuO_2–UO_2 assembly with about 25 wt % of enrichment has similar performance to the JPDR-II UO_2 assembly during burnup history up to about 10,000 MWD/T from the view point of reactivity equivalency and power distribution. It is shown that a composite fuel assembly with five different enriched PuO_2–UO_2 is desirable to suppress the local power peaking in the assembly under 1.2. (auth)

50890 RESEARCH AND DEVELOPMENT STUDIES IN ENVIRONMENTAL POLLUTION AND IN REACTOR COOLING SYSTEMS. NUCLEAR ENGINEERING. PART XXI. Moen, R. H. (ed.). Chem. Eng. Progr., Symp. Ser.; 66: No. 104, 1-220 (1970).

Separate abstracts were prepared for 17 of the included papers. (M.O.W.)

For abstracts of individual papers see: 48523–48525, 49047, 49048, 49123, 49883, 50891, 50892, 51071–51075, 51110, 51141, and 51173.

50891 HELIUM PURIFICATION FOR HIGH TEMPERATURE GAS-COOLED REACTORS. Gitterman, Morris. Chem. Eng. Progr., Symp. Ser.; 66: No. 104, 31-40(1970).

There are two basic requirements for purifying the helium used as the primary coolant in high temperature gas-cooled reactors; control of fission products released from the core, and control of chemical impurities. These requirements essentially define the process design of the helium purification system. The capacity of the system, however, may be significantly affected by the requirements for a supply of purified helium for use within the plant, as well as the necessity of coping with various postulated accidents. The effect of these considerations on the design of the helium

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purification systems for the Peach Bottom No. 1 and Fort St. Vrain Nuclear Power Plants is discussed. (auth)

50892 PERFORMANCE OF COOLANT CLEAN-UP SYSTEM IN THE PEACH BOTTOM REACTOR. Knapp, Walter J. Jr.; Lutz, Paul E. (Philadelphia Electric Co.). Chem. Eng. Progr., Symp. Ser.; 66: No. 104, 41-9(1970).

The coolant clean-up systems in the Peach Bottom Reactor are described. These systems incorporate various beds, traps, filters and condensers to remove both chemical and radio-chemical impurities. The processes make use of filtration, oxidation, reduction, adsorption, and condensation to preserve fuel integrity, prevent gross plateout of radioactivity in main coolant piping and steam generators, and minimize release of fission products to the environment. (auth)

50893 ENRICO FERMI SODIUM PURITY AND FISSION PRODUCT DETECTION EXPERIENCE. Batch, M. L. (Atomic Power Development Associates, Inc., Detroit); Coleman, J. H.; Ross, T. P.; Wilson, C. L. Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 8-9(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

50894 LACBWR NUCLEAR INSTRUMENTATION NON-LINEARITY COMPENSATION. Corcoran, R. L. (Dairyland Power Cooperative, Genoa, Wis.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 9-10(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

50895 OPERATIONAL PERFORMANCE OF WESTINGHOUSE PWR CONTROL SYSTEMS. Burnett, T. W. T.; Geets, J. M.; Ginsberg, P. M. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 10(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

50896 SODIUM HYDRAULIC AND THERMAL PERFORMANCE OF THE ENRICO FERMI REACTOR THROUGH 200 MW. Zaman, S. U. (Atomic Power Development Associates, Inc., Detroit); Ford, J. A.; Wilber, H. A. Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 16-17 (1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

50897 LA CROSSE BOILING WATER REACTOR FUEL PIN BOWING: DISCOVERY, STUDY, AND SOLUTION. Raffety, Seymour J. (Dairyland Power Cooperative, Genoa, Wis.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 18(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

50898 REPAIR OF THERMAL SLEEVE AND PRIMARY COOLANT PIPE AT INDIAN POINT UNIT NO. 1. McCormick, Donald J.; Long, Robert L. (Consolidated Edison Co. of New York, Buchanan). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 26 (1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

50899 DIFFICULTIES WITH FURNACE-SENSITIZED STAINLESS-STEEL SAFE ENDS AT THE NINE MILE POINT NUCLEAR STATION. Burt, P. Allister (Niagara Mohawk Power Corp., Lycoming, N. Y.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 26-7(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

50900 COOLANT ACTIVITY AT CONNECTICUT YANKEE, CORES I AND II. Hartley, F. W. (Connecticut Yankee Atomic Power Co., East Hampton). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 27-8(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

50901 OPERATIONAL ASPECTS AND PERFORMANCE OF FERMI ON-LINE COMPUTER. Cox, Terel H. (Atomic Power Development Associates, Inc., Detroit); Volk, E. R.; Masters, S. M.; (and others). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 34-5(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

50902 PRINCIPLES AND RESULTS OF AUTOMATIC CONTROL SYSTEM START-UP IN THE RHEINSBERG NUCLEAR POWER PLANT. PROBLEMS OF DEVELOPMENT. Schumacher, G. (VEB Kernkraftwerk, Rheinsberg, Ger.). Kernenergie; 14: No. 4, 107-10(Apr 1971). (In German).

The technological and economical outlook, organization and techniques of startup and optimization of the automatic control system in the Rheinsberg nuclear power plant are reported. Results are presented, and hints at future startup procedures of automatic control systems in nuclear power plants are derived. The method of predetermining the optimum parameters of automatic control is evaluated, and an orientation for improving startup procedures of future nuclear power plants based on the technological and economical analysis of startup is given. (auth)

50903 DETECTION OF SODIUM WATER LEAKS IN PFR SECONDARY HEAT EXCHANGERS. Davies, R. A.; Drummond, J. L.; Adaway, D. W. (United Kingdom Atomic Energy Authority, Dounreay, Eng.). Nucl. Eng. Int.; 16: 493-5(Jun 1971).

The use of single tube steam generators in power plants with sodium cooled reactors requires a fast response, high sensitivity method for the detection of leaks. The hydrogen produced by sodium-water reactions is taken as an indication of a leak. Methods developed for the detection of hydrogen in the argon cover gas or in the sodium circuits, using Ni membranes, are described. (auth) (UK)

50904 MANUFACTURE AND ERECTION OF THE MUEHLEBERG PRESSURE VESSEL. Straub, H.; Ammann, H. Sulzer Tech. Rev.; 53: No. 1, 27-34(1971).

Fabrication and erection of the first reactor pressure vessel to be built in Switzerland are described. Planning, design and calculation are passed over briefly, in order to devote more space to the details and problems of fabrication. (auth)

50905 PRESENT STATE AND FUTURE ASPECTS OF THE PRODUCTION OF NUCLEAR ENERGY IN THE UNITED STATES. Larson, C. Energ. Nucl. (Madrid); 14: No. 68, 471-81(Nov-Dec 1970). (In Spanish).

The reasons for the development of nuclear energy in the United States, its present state, and future prospects are analyzed. The safety characteristics of nuclear power plants are emphasized. The development of advanced reactors will take priority in the future. Of first priority are the liquid-metal cooled fast breeder reactors, but the gas-cooled high-temperature reactor, light-water breeder reactors, and fused salt reactors are also of importance. (tr-auth)

50906 ATOMIC ENERGY DEVELOPMENT IN PAKISTAN. Indian J. Power River Valley Develop.; 20: No. 8, 344-6(Aug 1970).

Various activities of the Pakistan Institute of Nuclear Science & Technology and other nuclear research centers in Pakistan are described. The reactor at Karachi, the Rooppur Nuclear Power Project, and the nuclear power-cum-desalination plant at Karachi are discussed. A brief account of the nuclear mineral resources of Pakistan is given. (D.S.R.M) (INIS)

50907 LOVIISA NUCLEAR POWER STATION. Nucl. Eng. Int.; 16: 417-19(May 1971).

The main features of the 420 MW(e) PWR station for Finland are described. Site conditions are outlined. Important features of the containment building are the inclusion of basements below the steel barrier, housing most of the penetrations, and the inclusion of an ice condenser around the inner concrete wall. The reactor is of the Novo Voronezh type. UO_2 fuel pellets are clad in Zr–Nb alloy, the target burn-up being 29,000 MWd/te. The pressure vessel is designed for 127 kg/cm^2, with outlet temp 300°C. The use of six primary loops with horizontal steam generators results in a station of considerable size. Safety features are compared with Western standards. Some costs are given. (UK)

50908 OUTLOOK FOR THE INTERMEDIATE REACTOR MARKET DISCUSSED AT THE OSLO SYMPOSIUM. Bonnet, Robert (CEA, Fontenay-aux-Roses, France). Energ. Nucl. (Paris); 13: No. 2, 148-51(Mar-Apr 1971). (In French).

An analysis was made on economic, financial, and political problems connected with the use of intermediate size reactors, particularly in developing countries. (France)

50909 OFFGAS FACILITY AT THE GUNDREMMINGEN NUCLEAR POWER PLANT. Schroeder, H. J. (Kernkraftwerk RWE-Bayernwerk GmbH, Gundremmingen, Ger.); Queiser, H.; Reim, W. Kerntech. Atomprax.; 13: No. 5, 205-13(May 1971). (In German and English).

The facility for the processing and elimination of the radiolysis gases and radioactive inert gases generated in the reactor of the Gundremmingen nuclear power plant is described. After some initial difficulties were overcome, this facility has been successfully in operation since 1967. An activated charcoal adsorption

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line makes it possible to achieve for krypton and xenon retention times of 1 day and 14 days respectively. 4 references. (auth)

50910 POWER NEEDS AND POWER PROBLEMS: PAST, PRESENT, AND FUTURE. Thompson, Theos J. (Atomic Energy Commission, Washington, D. C. Amer. J. Public Health; 61: No. 7, 1406-15(Jul 1971).

Future power requirements in the U. S. are discussed. Actual and potential sources of power are examined, and some of the environmental problems involved in power production are presented. (H.D.R.)

Operation and Economics

Refer also to abstract 48781.

50911 (DLCS-5000171) QUARTERLY OPERATING REPORT, First Quarter 1971. (Duquesne Light Co., Shippingport, Pa.). Contract AT(11-1)-292. 21p. Dep. NTIS.

During the first quarter of 1971, the Shippingport Atomic Power Station was operated for Duquesne Light Company system load demand, testing and maintenance. The heat dissipation system was in operation from January 20 through January 24. At the beginning of the period, the station was operating with 3 reactor coolant loops in service with the 1C loop isolated and drained for maintenance. On January 17, the 1C loop was returned to service and the station operated with 4 loop full-flow conditions to establish equilibrium xenon. The load was increased to 100% power (150 MWG) on January 22 and maintained for 48 hours. A routine chemical analysis of the 1A boiler on January 14 indicated a primary to secondary leak rate of approximately 0.1 gph. At the end of the period the 1A boiler leak rate had increased to 9 gph. On February 4, a primary to secondary leak of approximately 2 gph was detected in 1D boiler. The 1D boiler was cooled down for tube inspection and repairs on February 17. The boiler remained out of service for the remainder of the quarter. The reactor coolant system net leak rate at the beginning of the period was determined to be 12 gph, and 20 gph by the end of the period. On January 16, a reactor safety insertion-high power in intermediate range incident occurred resulting from a rapid increase in power. The cause was determined to be a malfunction of the main turbine governor. On February 12, the main unit generator was taken off the line, but the reactor was maintained critical for hot plant reactor physics testing. A shutdown and plant cooldown was undertaken on February 15 for operations, testing, and training. The station returned to power operation on March 10. On March 15, nightly training shutdowns were initiated for Class II candidates and continued to the end of the period. The 1D loop remained isolated and drained at the end of the period. (auth)

50912 (DOCKET-1155-132) LA CROSSE BOILING WATER REACTOR. 1A Diesel Fire Pump Starting Motor Failure. (Dairyland Power Cooperative, La Crosse, Wis.). 18 Aug 1971. 3p. (DPC-71-16). Dep. NTIS.

50913 (DOCKET-50003-86) INDIAN POINT STATION, UNIT NO. 1. Supplement to Report of March 12, 1971 Concerning Foreign Material in Control Rod Buffer Seal Housings. (Consolidated Edison Co. of New York, Inc., New York). 26 Aug 1971. 6p. Dep. NTIS.

50914 (DOCKET-50003-87) INDIAN POINT STATION, UNIT NO. 1. Binding of Control Rod No. 12. (Consolidated Edison Co. of New York, Inc., New York). 26 Aug 1971. 4p. Dep. NTIS.

50915 (DOCKET-50010-92) DRESDEN NUCLEAR POWER STATION, UNIT 1. Ground Level Release of Off Gas Without Holdup and Filtration on August 12, 1971. (Commonwealth Edison Co., Chicago, Ill.). 21 Aug 1971. 2p. Dep. NTIS.

50916 (DOCKET-50010-93) DRESDEN NUCLEAR POWER STATION, UNIT 1. One of Six Micromicroammeters Failed to Actuate a Reactor Protection Channel Trip. (Commonwealth Edison Co., Chicago, Ill.). 26 Aug 1971. 2p. Dep. NTIS.

50917 (DOCKET-50016-125) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1. Building Isolation From Radiation Detector Found Inoperative on Routine Check. (Power Reactor Development Co., Detroit, Mich.). 23 Aug 1971. 1p. Dep. NTIS.

50918 (DOCKET-50029-156) YANKEE NUCLEAR POWER STATION. Operation Report No. 127, July 1971. (Yankee Atomic Electric Co., Westboro, Mass.). 20 Aug 1971. 9p. Dep. NTIS.

50919 (DOCKET-50029-157) YANKEE NUCLEAR POWER STATION. Inservice Inspection and Primary System Leakage. (Yankee Atomic Electric Co., Westboro, Mass.). 30 Aug 1971. 6p. Dep. NTIS.

50920 (DOCKET-50133-65) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. Radiation Exposure of an Individual. (Pacific Gas and Electric Co., San Francisco, Calif.). 2 Aug 1971. 4p. Dep. NTIS.

50921 (DOCKET-50133-66) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. Operating Report, January 1-June 30, 1971. (Pacific Gas and Electric Co., San Francisco, Calif.). 20 Aug 1971. 24p. Dep. NTIS.

50922 (DOCKET-50220-69) NINE MILE POINT NUCLEAR STATION, UNIT NO. 1. Fourth Semiannual Report of Operation, January 1-June 30, 1971. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 26 Aug 1971. 23p. Dep. NTIS.

50923 (DOCKET-50220-72) NINE MILE POINT NUCLEAR STATION, UNIT NO. 1. Malfunction of Equipment in Radiation Waste Facility. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 3 Sep 1971. 2p. Dep. NTIS.

50924 (DOCKET-50237-196) DRESDEN NUCLEAR POWER STATION, UNIT 2. Amplifying Information to H. K. Hoyt's Letter of June 21, 1971 to Dr. Peter A. Morris, DOCKET-50237-181. (Commonwealth Edison Co., Chicago, Ill.). 23 Aug 1971. 1p. Dep. NTIS.

Additional information is presented concerning the failure of the closing coil on the backup power supply to the injection valves of the low pressure coolant injection system. The failure was caused by reduced voltage to the closing coil. Corrective actions are described. (D.C.C.)

50925 (DOCKET-50245-86) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Abnormal Occurrence No. A0-71-13, Switch PIS-1620B Failed to Actuate on Applying Test Pressure. (Millstone Point Co., Hartford, Conn.). 19 Aug 1971. 1p. Dep. NTIS.

Test failure of a high drywell pressure switch for initiating the automatic pressure relief function is described. Corrective actions are discussed. (D.C.C.)

50926 (DOCKET-50245-88) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Operation Reports Nos. 1-6, January 1-June 30, 1971. (Millstone Point Co., Wethersfield, Conn.). 3 Sep 1971. 69p. Dep. NTIS.

50927 (DOCKET-50249-98) DRESDEN NUCLEAR POWER STATION, UNIT 3. Failure of Unit 2/3 Diesel Generator to Start on Test. (Commonwealth Edison Co., Chicago, Ill.). 20 Aug 1971. 2p. Dep. NTIS.

50928 (DOCKET-50255-52) PALISADES PLANT. Failure of Mechanical Seal Unit of a Primary Coolant Pump. (Consumers Power Co., Jackson, Mich.). 27 Aug 1971. 2p. Dep. NTIS.

50929 (DOCKET-50261-70) H. B. ROBINSON UNIT NO. 2. Latch Pin on Reactor Trip Breaker Broken. (Carolina Power and Light Co., Raleigh, N. C.). 27 Aug 1971. 2p. Dep. NTIS.

50930 (DOCKET-50266-53) POINT BEACH NUCLEAR PLANT, UNITS 1 AND 2. Operation Report No. 2, January 1-June 30, 1971. (Wisconsin Electric Power Co., Milwaukee. Wisconsin Michigan Power Co., Appleton, Wis.). 9 Sep 1971. 36p. (DOCKET-50301-39). Dep. NTIS.

50931 (DOCKET-50301-37) POINT BEACH NUCLEAR PLANT, UNIT NO. 2. Repairs Made to Steam Generator B. (Wisconsin Electric Power Co., Milwaukee. Wisconsin Michigan Power Co., Appleton, Wis.). 20 Aug 1971. 235p. Dep. NTIS.

50932 (KAPL-P-3937) IMPROVING POWER SYSTEM RELIABILITY THROUGH STANDARDIZATION WITH SPECIFIC REFERENCE TO NUCLEAR POWER REACTORS. Fleischmann, Walter L.; Ringlee, Robert J. [Knolls Atomic Power Lab., Schenectady, N. Y.]. [15 Mar 1971]. 65p. Dep. NTIS.

The management practices to be applied to ensure reliable performance from nuclear power plants designed during rapidly evolving states of development are described. The practices include those established for data collection of outages of power plant equipment and those needed to ensure that experiences from operating plants and tests are fed into new designs of increased size. 47 references. (D.C.C.)

50933 (NYO-1859-17) SIXTEENTH ANNUAL PROGRESS REPORT OF THE PENNSYLVANIA STATE UNIVERSITY BREAZEALE NUCLEAR REACTOR, JULY 1, 1970-JUNE 30,

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1971. Levine, Samuel H. (Pennsylvania State Univ., University Park. Dept. of Nuclear Engineering). Contract AT(30-1)-1859-17. 76p. Dep. NTIS.

The reactor facility operation and utilization are summarized. Statistics applicable to the cobalt-60 facility and the radionuclear applications laboratory are included. (H.D.R.)

50934 (TID-25738) GUNDREMMINGEN NUCLEAR POWER PLANT. Monthly Report, March 1971. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen (West Germany)). 22 Apr 1971. 44p. (In German). Dep. NTIS.

The plant was operated throughout at full load except for a short load reduction in order to change the control rod actuation sequence and to carry out repeat tests. No serious malfunctions occurred; off-gas and water activities remained almost constantly low. The removal of irradiated fuel elements was successfully concluded. Altogether, 123 elements and 57 single pins were taken away in 14 shipments. During the month covered by the report, 85 drums with radioactive solid wastes were taken to Asse-2. Removal of the radioactive sludgy waste (111 m^3) was completed successfully. The modifications to the controlled area entrance are continuing. (auth)

50935 (TID-25785) GARIGLIANO NUCLEAR POWER STATION. Operation Report for the 4th Quarter of 1970. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). 31 Dec 1970. 17p. Dep. NTIS.

For the period January through March 1971, the Garigliano plant availability factor was 94.7% and the capacity factor was 90%. In February the recirculation pump in leg A of the primary circuit was found to be damaged. Plant operation continued at a reduced power level for the remainder of the reporting period. Plant activities summarized include: operating statistics; core performance; plant chemistry; and health physics. (H.D.R.)

50936 (TRG-Report-2097) COMPUTERISED MODEL OF THE NUCLEAR SECTOR OF AN ELECTRICITY GENERATING SYSTEM. Iliffe, C. E. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1971. 24p. (CONF-701102-22). Dep. NTIS (U. S. Sales Only).

From Meeting of the American Nuclear Society; Washington, D. C. (15 Nov 1970).

A simulation model of a nuclear power system is provided by the computer programme DISCOUNT. There are six different types of nuclear station, four plutonium-producing and two plutonium-feed. After the "base" date, to which all quantities are discounted, two of the plutonium-producing types as well as the plutonium-feed stations are commissioned as determined in the computer programme. Otherwise, all stations, both nuclear and conventional, are commissioned as called for in the input data. For each type of nuclear station the plutonium production and feed rate is quoted as a function of station operating time in the input data. The input data also includes the various out-of-pile delays in the plutonium fuel cycle. For each type of station the initial capital cost and operating charges are quoted in the input data as a function of commissioning date and the residual value, if any, as a function of withdrawal date. Charges due to replacement fuel and stocks of fuel held at the station are also quoted in the input data as functions of time. The output from the programme quotes, for every instant of time and for each type of station, the number of stations installed, their load factor, the cash flow to which they give rise, their highest and lowest, or "marginal", durations and their marginal costs. At any instant of time, the marginal cost is the mean generating cost of a station commissioned at that time which subsequently operates always at marginal duration. The plutonium stocks are also quoted for each instant of time. Besides this detailed output, the programme also furnishes a summary output giving, for each type of station, the total discounted expenditure, the total discounted capacity commissioned, the fixed and running components of the discounted mean present worth generating cost and the discounted mean load factor. 7 references. (auth)

50937 REACTOR AVAILABILITY AND STATION RELIABILITY FOR CONTINUITY OF SERVICE. Hagen, E. W. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 11-12(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

50938 REACTOR OPERATING EXPERIENCE IN THE EUROPEAN COMMUNITY. Siebker, Manfred H. (Commission of the European Communities, Brussels). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 12-13(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

50939 POINT BEACH LOAD FOLLOW TEST. Kutz, J. P. (Westinghouse Electric Corp., Pittsburgh); Newton, R. A. Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 13-14(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

50940 AXIAL STABILITY MEASUREMENTS AT THE ROCHESTER GAS AND ELECTRIC REACTOR. Lee, John C. (Westinghouse Electric Corp., Pittsburgh); Jones, Kenneth A.; McCoy, William L. Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 15(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

50941 ENRICO FERMI CORE AND REACTOR THERMAL EXPERIENCE. Callen, R. C. (Atomic Power Development Associates, Inc., Detroit); Michael, H. R.; Friedland, A. J.; Battista, G.; Alexanderson, E. L. Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 15-16(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

50942 CORE DATA UTILIZATION AT POINT BEACH NUCLEAR PLANT. Newton, Roger A.; Pitterle, Norbert L. (Wisconsin Michigan Power Co., Two Rivers, Wis.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 32(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

50943 RETRAINING EXPERIENCE AT R. E. GINNA STATION. White, L. D. Jr. (Rochester Gas and Electric Co., N. Y.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 51-2(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

50944 MAINTAINING THE COMPETENCE OF A NUCLEAR POWER PLANT STAFF. Raymond, W. A. (Pacific Gas and Electric Co., San Francisco). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 52-3(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

50945 RESULTS OF NUCLEAR TESTING ON THE ENRICO FERMI REACTOR THROUGH 200 MW. Klickman, A. E. (Atomic Power Development Associates, Inc., Detroit); Ball, G. L.; Batch, M. L.; Kishida, T.; Alexanderson, E. L. Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 54(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

50946 ENRICO FERMI SYSTEM DYNAMICS AND TRANSIENT PERFORMANCE. Hosler, A. G. (Atomic Power Development Associates, Inc., Detroit); Sato, K.; Smith, D. B.; Ziniuk, M. A. Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 54-5 (1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

50947 PREOPERATIONAL TESTING AT FORT ST. VRAIN. Swart, F. E. (Public Service Co. of Colorado, Denver); Wheeler, C. C. Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 55(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

50948 PEACH BOTTOM HTGR, CORE-2 STARTUP PHYSICS TESTING AND OPERATION. Schleifer, Paul (Gulf General Atomic Co., San Diego, Calif.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 55-6(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

50949 STARTUP EXPERIENCE AT POINT BEACH NUCLEAR PLANT. Newton, Roger A.; Rodgers, Tom J.; Zach, James J. (Wisconsin Michigan Power Co., Two Rivers, Wis.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 56-7(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

50950 NUCLEAR TEST RESULTS FROM A 2200-MW(th) PWR. Brandon, R. W. (Westinghouse Electric Corp., Pittsburgh); Watson R. A. Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 57(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

50951 MEASUREMENTS TO CONFIRM THE TSURUGA BWR POWER DISTRIBUTION BY GAMMA SCAN OF FUEL ASSEMBLIES. Aline, P. G. (General Electric Co., San Jose, Calif.); Duckart, A. C.; Egan, M. R.; Imai, R. Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 58-9(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

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50952 ELECTRIC POWER PRODUCTION IN ITALY. Angelini, Arnaldo M. (Ente Nazionale per l'Energia Elettrica, Rome). Proc. Inst. Mech. Eng. (London); 184: No. 62, 1135-45(1969-70).

A survey is presented of power generation and installed capacity in Italy since the beginning of the century, with reference to the contribution and relative incidence of the various primary sources exploited. A summary review is included of the evolution of the main characteristics of hydro plants designed for power generation and regulation, fossil-fired steam power stations, and nuclear power stations, with reference to the structure of the station and to the rating and main features of the generating units. Prospects are discussed and the foreseeable evolution of generating plants in relation to the availability and competitiveness of the primary sources of energy; and hydroelectric plants for power regulation. (auth) (UK)

50953 PLANNING PROBLEMS CONNECTED WITH NUCLEAR POWER INTEGRATION IN THE FEDERAL REPUBLIC OF GERMANY. Huenlich, Werner H. F. (Vereinigung Deutsche Elektrizitaetswerke, Frankfurt am Main). At. Strom; 17: No. 5, 74-83(May 1971). (In German).

On the basis of the actual situation of the electricity supply industry in the Federal Republic of Germany, planning problems of utilities are described concerning the use of large nuclear power units. Particular attention is paid to the technical and economic development tendencies as well as to the competition on the fuel market. 8 references. (auth)

Safety and Siting

Refer also to abstracts 48616, 49171, and 49187.

50954 (CONF-710523-1) TURBULENT DIFFUSION IN THE OCEAN AND BAY IN THE JERVIS BAY AREA. Charash, E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). [1970]. 22p. Dep. NTIS (U. S. Sales Only).

From Annual conference on the Marine Sciences Association; Brisbane, Australia (21 May 1971).

A description is given of observations made using tethered drogue systems, dye diffusion and aerial color photography on 2 adjacent areas in Jervis Bay and in an ocean area extending 1 km southwards from Bowen Island and 1 km from the shore. Current speeds averaged 20 cm sec^{-1} near shore, 40 cm sec^{-1} coastal and 10 to 20 cm sec^{-1} in the bay. Plume shapes in the bay were remarkably uniform, and in the ocean three different plume shapes were generated. Turbulence intensities and spectra in the ocean were of considerably wider range than those in the bay. Diffusivities for the different plumes at distances of 3 and 300 m from the source are tabulated. From these results comparative estimates are made of the contributions of heat transfer and turbulent diffusion in reducing the temperature of a heated effluent by 10%. 7 references. (Australia)

50955 (DOCKET-1151-45) ELK RIVER REACTOR. Technical Specifications, Change Request No. 15. (Rural Cooperative Power Association, Elk River, Minn.). 13 Aug 1971. 5p. Dep. NTIS.

Revised technical specifications concerning the storage and shipment of radioactive waste are presented. (D.C.C.)

50956 (DOCKET-1151-46) ELK RIVER REACTOR. Dismantling Plan. (Rural Cooperative Power Association, Elk River, Minn. Gulf United Nuclear Fuels Corp., Elmsford, N. Y.). 27 Aug 1971. Contract AT(11-1)-651. 83p. Dep. NTIS.

50957 (DOCKET-1154-5) BONUS NUCLEAR POWER PLANT. Contract for Radioactivity Surveillance. (Puerto Rico Water Resources Authority, San Juan). 16 Aug 1971. Contract AT(40-1)-4186. 14p. Dep. NTIS.

50958 (DOCKET-1155-133) LA CROSSE BOILING WATER REACTOR. Changes to Technical Specifications, Use of Respiratory Equipment. (Dairyland Power Cooperative, La Crosse, Wis.). 1 Sep 1971. 19p. Dep. NTIS.

50959 (DOCKET-50133-64) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. Change No. 35 to the Technical Specifications of the Facility License No. DPR-7. (Division of Reactor Licensing (AEC), Washington, D. C.). 25 Aug 1971. 6p. Dep. NTIS.

Revised technical specifications are presented concerning control rods. Operating limits for Type 2 and 3 fuel elements for Cycle 6 and Cycle 7 operations are listed. (D.C.C.)

50960 (DOCKET-50146-89) SAXTON REACTOR. Technical Specifications, Change Request No. 41, Amendment No. 1. (Saxton Nuclear Experimental Corp., Pa.). 20 Aug 1971. 5p. Dep. NTIS.

Revised technical specifications are presented concerning the operating limits for Zircaloy 4-clad PuO_2-UO_2 fuel rods. (D.C.C.)

50961 (DOCKET-50146-90) SAXTON REACTOR. Change No. 46 to Technical Specifications of Facility License No. DPR-4. (Division of Reactor Licensing (AEC), Washington, D. C.). 27 Aug 1971. 2p. Dep. NTIS.

Revised technical specifications are presented concerning design requirements of test fuel element assemblies. The fuel assemblies have Zircaloy 4 clad UO_2 rods and Zircaloy 4 water-filled hollow tubes. (D.C.C.)

50962 (DOCKET-50206-121) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. October 1970 Nondestructive Inservice Inspection. (Southern California Edison Co., Los Angeles). Jul 1971. 29p. Dep. NTIS.

50963 (DOCKET-50206-122) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Analysis of First Surveillance Material Capsule. (Southern California Edison Co., Los Angeles). Jul 1971. 50p. Dep. NTIS.

The first material surveillance capsule was removed from the San Onofre Unit 1 vessel during the 1970 refueling outage. The test procedures used and results obtained are presented. Based on the specimen evaluations, the San Onofre vessel plate tested has less sensitivity to radiation embrittlement than many other plates of the same alloy class previously tested and reported in the literature. (auth)

50964 (DOCKET-50213-117) CONNECTICUT YANKEE ATOMIC POWER PLANT. Environmental Radiation Survey Program. Semiannual Report, January 1-June 30, 1971. (ICN/Tracerlab, Waltham, Mass.). 20 Aug 1971. 30p. Dep. NTIS.

For Connecticut Yankee Atomic Power Co., Haddam.

50965 (DOCKET-50219-143) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Amendment No. 67, Reanalysis of Emergency Core Cooling System. (Jersey Central Power and Light Co., Morristown, N. J.). 3 Sep 1971. 26p. Dep. NTIS.

Requested additional information on the emergency core cooling system is presented. Performance evaluation for the emergency core cooling system is included. (D.C.C.)

50966 (DOCKET-50219-144) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Facility Change Request No. 1. (Jersey Central Power and Light Co., Morristown, N. J.). 9 Sep 1971. 23p. Dep. NTIS.

Design parameters and operating limits for $Gd_2O_3-UO_2$ Type 2 reload fuel elements are presented. (D.C.C.)

50967 (DOCKET-50220-67) NINE MILE POINT NUCLEAR STATION, UNIT NO. 1. Analysis of Initial Core. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 20 Aug 1971. 27p. Dep. NTIS.

Requested additional information is presented concerning performance of the emergency core cooling system for the initial core. (D.C.C.)

50968 (DOCKET-50220-68) NINE MILE POINT NUCLEAR STATION, UNIT NO. 1. Additional Information on Partial Refueling Requested by Letter of August 13, 1971. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 20 Aug 1971. 9p. Dep. NTIS.

Additional information concerning performance limits of $Gd_2O_3-UO_2$ fuel rods is presented. Performance requirements for the emergency core cooling system are described for the partially refueled core. (D.C.C.)

50969 (DOCKET-50220-70) NINE MILE POINT NUCLEAR STATION, UNIT NO. 1. Activities not in Compliance with License Requirements on March 3, 10-12, and 16-18, 1971. (Division of Compliance (AEC), Washington, D. C.). 26 Aug 1971. 4p. Dep. NTIS.

Failure to report liquid radioactive effluent releases is described. Inadequate actions for radiation survey of personnel are discussed. Excessive liquid radioactive effluent releases are listed. (D.C.C.)

50970 (DOCKET-50220-71) NINE MILE POINT NUCLEAR STATION, UNIT NO. 1. Possible Consequences of Loading Errors Associated with Refueling. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 30 Aug 1971. 6p. Dep. NTIS.

50971 (DOCKET-50244-76) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT NO. 1. Emergency Core Cooling Performance Report. (Rochester Gas and Electric Corp., N. Y.). 9 Sep 1971. 84p. Dep. NTIS.

50972 (DOCKET-50245-87) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Environmental Radiation Survey Program.

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Semiannual Report, January 1–June 30, 1971. (ICN/Traceriab, Waltham, Mass.). 25 Aug 1971. 44p. Dep. NTIS.
For Millstone Point Co., Wethersfield, Conn.

50973 (DOCKET-50247–47) INDIAN POINT NUCLEAR GENERATING UNIT NO. 2. Containment Vessel Structural Integrity Test. (United Engineers and Constructors Inc., Philadelphia, Pa.). 28 May 1971. 349p. Dep. NTIS.
For Westinghouse Electric Corp., [Pittsburgh, Pa.].

50974 (DOCKET-50247–48) INDIAN POINT NUCLEAR GENERATING UNIT NO. 2. Environmental Report, Suppl. No. 1. (Consolidated Edison Co. of New York, Inc., New York). Sep 1971. 300p. Dep. NTIS.
Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

50975 (DOCKET-50247–49) INDIAN POINT NUCLEAR GENERATING UNIT NO. 2. Environmental Report, Suppl. No. 1. Appendices, Vol. 1. (Consolidated Edison Co. of New York, Inc., New York). Sep 1971. 700p. Dep. NTIS.
Hydrological and meteorological data for the reactor site are presented. The effects of thermal discharge from the reactor on the Hudson River temperature distribution are analyzed. (D.C.C.)

50976 (DOCKET-50247–50) INDIAN POINT NUCLEAR GENERATING UNIT NO. 2. Environmental Report, Suppl. No. 1. Appendices, Vol. 2. (Consolidated Edison Co. of New York, Inc., New York). Sep 1971. 600p. Dep. NTIS.
Data for the ecological survey during June 1969 to June 1970 are presented. Radiation monitoring data for August 1965 and July 1966 are included. Environmental studies and monitoring programs are described. (D.C.C.)

50977 (DOCKET-50254–51) QUAD-CITIES STATION, UNITS 1 AND 2. Safety Evaluation. (Division oi Reactor Licensing (AEC), Washington, D. C.). 25 Aug 1971. 144p. (DOCKET-50265–43). Dep. NTIS.

50978 (DOCKET-50255–51) PALISADES PLANT. Supplemental Information on Environmental Impact. (Consumers Power Co., Jackson, Mich.). 18 Aug 1971. 556p. Dep. NTIS.
Information concerning thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Radiation survey measurements for June 1968 to March 1971 are included. (D.C.C.)

50979 (DOCKET-50261–68) H. B. ROBINSON UNIT NO. 2. Change Requested to Clarify Definition of Rated Power. (Carolina Power and Light Co., Raleigh, N. C.). 24 Aug 1971. 1p. Dep. NTIS.
A revised definition of core thermal power rating of 2200 MW(t) is presented. (D.C.C.)

50980 (DOCKET-50261–69) H. B. ROBINSON UNIT NO. 2. Technical Specifications, Change Request. (Carolina Power and Light Co., Raleigh, N. C.). 23 Aug 1971. 1p. Dep. NTIS.
Revised technical specifications concerning the definition of rated power for the power station are presented. The rating of 2200 MW(t) is redefined to represent core thermal power only. (D.C.C.)

50981 (DOCKET-50263–80) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Environmental Monitoring and Ecological Studies Program 1970 Annual Report, Errata and Addenda. (Northern States Power Co., Minneapolis, Minn.). 27 Aug 1971. 3p. Dep. NTIS.

50982 (DOCKET-50263–81) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Technical Specifications, Change Request No. 3. (Northern States Power Co., Minneapolis, Minn.). 20 Aug 1971. 40p. Dep. NTIS.
Revised technical specifications are presented concerning safety limits for Monticello Power Reactor Unit 1 operations. (D.C.C.)

50983 (DOCKET-50272–13) SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2. Technical Specifications. (Public Service Electric and Gas Co., Newark, N. J.). 27 Aug 1971. 174p. (DOCKET-50311–13). Dep. NTIS.

50984 (DOCKET-50272–14) SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2. Final Safety Analysis Report, Vol. 1. (Public Service Electric and Gas Co., Newark, N. J.). 27 Aug 1971. 386p. (DOCKET-50311–14). Dep. NTIS.
Information on the Salem Power Reactor Units 1 and 2 is presented under the following broad topics: site and environment; reactor; and reactor coolant system. (D.C.C.)

50985 (DOCKET-50272–15) SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2. Final Safety Analysis Report, Vol. 2. (Public Service Electric and Gas Co., Newark, N. J.). 27 Aug 1971. 293p. (DOCKET-50311–15). Dep. NTIS.
Information on the Salem Power Reactor Units 1 and 2 is presented under the following broad topics: containment systems; and engineered safety features. (D.C.C.)

50986 (DOCKET-50272–16) SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2. Final Safety Analysis Report, Vol. 3. (Public Service Electric and Gas Co., Newark, N. J.). 27 Aug 1971. 372p. (DOCKET-50311–16). Dep. NTIS.
Information on the Salem Power Reactor Units 1 and 2 is presented under the following broad topics: instrumentation and control; electrical systems; auxiliary and emergency systems; steam and power conversion system; and waste disposal and radiation protection systems. (D.C.C.)

50987 (DOCKET-50272–17) SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2. Final Safety Analysis Report, Vol. 4. (Public Service Electric and Gas Co., Newark, N. J.). 27 Aug 1971. 386p. (DOCKET-50311–17). Dep. NTIS.
Information on the Salem Power Reactor Units 1 and 2 is presented under the following broad topics: conduct of operations; initial tests and operations; and safety analysis. (D.C.C.)

50988 (DOCKET-50272–18) SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2. Final Safety Analysis Report, Vol. 5. (Public Service Electric and Gas Co., Newark, N. J.). 27 Aug 1971. 379p. (DOCKET-50311–18). Dep. NTIS.
Information on the Salem Power Reactor Units 1 and 2 is presented under the following headings: environmental monitoring program; site environmental studies; seismic design criteria for structures and equipment; quality assurance; iodine removal effectiveness of containment spray system; high pressure turbine rotor fracture and low pressure turbine disc fractures at design overspeed; pressure vessel NDTT; and radiation sources. (D.C.C.)

50989 (DOCKET-50272–19) [SALEM NUCLEAR GENERATING STATION] (FORMERLY BURLINGTON NUCLEAR GENERATING STATION). Preliminary Facility Description and Safety Analysis Report, First Supplement. (Public Service Electric and Gas Co., Newark, N. J.). 24 Oct 1967. 99p. (DOCKET-50311–19). Dep. NTIS.
Requested additional information is presented concerning the containment structure, protection system, and engineered safeguards. (D.C.C.)

50990 (DOCKET-50285–48) FORT CALHOUN STATION, UNIT NO. 1. Final Safety Analysis Report, Supplement No. 11. (Omaha Public Power District, Nebr.). 27 Aug 1971. 100p. Dep. NTIS.
Revised and additional data on the design parameters and operations aspects of the Fort Calhoun Power Reactor Unit 1 are presented. Qualifications of startup personnel are listed. (D.C.C.)

50991 (DOCKET-50293–54) PILGRIM NUCLEAR POWER STATION. Safety Evaluation. (Division of Reactor Licensing (AEC), Washington, D. C.). 25 Aug 1971. 130p. Dep. NTIS.

50992 (DOCKET-50295–28) ZION STATION, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 13. (Commonwealth Edison Co., Chicago, Ill.). 13 Aug 1971. 108p. (DOCKET-50304–27). Dep. NTIS.
Ultrasonic inspection of the Zion Power Reactor Unit 1 pressure vessel is described. Defects in the circumferential weld between the transition forging and the lower head are discussed. Corrective actions taken are described. (D.C.C.)

50993 (DOCKET-50295–29) ZION STATION, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 14. (Commonwealth Edison Co., Chicago, Ill.). 13 Aug 1971. 266p. (DOCKET-50304–28). Dep. NTIS.
Information on the Zion Power Reactor Units 1 and 2 is presented under the following broad topics: site and environment; reactor; reactor coolant system; containment; engineered safety features; instrumentation and control; and electrical systems. (D.C.C.)

50994 (DOCKET-50301–38) POINT BEACH NUCLEAR PLANT, UNIT NO. 2. Emergency Core Cooling Performance. (Wisconsin Electric Power Co., Milwaukee. Wisconsin Michigan Power Co., Appleton, Wis.). 1 Sep 1971. 79p. Dep. NTIS.

50995 (DOCKET-50315–45) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Benton Harbor Power Plant Limnological Studies. Part VIII. Winter Operations, 1970–1971. (Michigan Univ., Ann Arbor. Great Lakes Research Div.). Jun 1971. 37p. (DOCKET-50316–45). Dep. NTIS.

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For American Electric Power Service Corp. and Indiana and Michigan Electric Co.

50996 (DOCKET-50315–46) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 16. (Indiana and Michigan Electric Co., Fort Wayne, Ind.). 31 Aug 1971. 600p. (DOCKET-50316–46). Dep. NTIS.

Revised design parameters of the Donald C. Cook Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

50997 (DOCKET-50317–27) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 13. (Baltimore Gas and Electric Co., Md.). 10 Sep 1971. 197p. (DOCKET-50318–27). Dep. NTIS.

Revised and additional information is presented concerning design parameters and operations aspects of the Calvert Cliffs Power Reactor Units 1 and 2. (D.C.C.)

50998 (DOCKET-50348–23) JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 19. (Alabama Power Co., Birmingham). 19 Aug 1971. 164p. (DOCKET-50364–17). Dep. NTIS.

Revised design parameters of the Joseph M. Farley Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. The emergency core coding system performance evaluation is presented. (D.C.C.)

50999 (DOCKET-50358–25) WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 18. (Cincinnati Gas and Electric Co., Ohio, Columbus and Southern Ohio Electric Co., Columbus, Ohio, Dayton Power and Light Co., Ohio). 23 Aug 1971. 47p. Dep. NTIS.

Revised design parameters of the William H. Zimmer Power Reactor Unit 1 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

51000 (DOCKET-50366–14) EDWIN I. HATCH NUCLEAR PLANT, UNIT 2. Preliminary Safety Analysis Report, Amendment 8. (Georgia Power Co., Atlanta). 25 Aug 1971. 82p. Dep. NTIS.

Revised design parameters of the Edwin I. Hatch Power Reactor Unit 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

51001 (DOCKET-50373–9) LA SALLE COUNTY STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 4. (Commonwealth Edison Co., Chicago, Ill.). 16 Aug 1971. 728p. (DOCKET-50374–9). Dep. NTIS.

Revised design parameters of the La Salle County Power Reactor Units 1 and 2 are presented. Included also are additional data on the the reactor requested by the Division of Reactor Licensing. (D.C.C.)

51002 (DOCKET-50376–20) AGUIRRE NUCLEAR PLANT, UNIT NO. 1. Preliminary Facility Description and Safety Analysis Report, Amendment 9. (Puerto Rico Water Resources Authority, San Juan). 3 Sep 1971. 349p. Dep. NTIS.

Revised design parameters of the Aguirre Power Reactor Unit 1 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

51003 (DOCKET-50382–10) WATERFORD STEAM ELECTRIC STATION, UNITS 3 AND 4. Preliminary Safety Analysis Report, Amendment 5. (Louisiana Power and Light Co., New Orleans). 27 Aug 1971. 146p. (DOCKET-50383–10). Dep. NTIS.

Revised design parameters of the Waterford Power Reactor Units 3 and 4 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

51004 (DOCKET-50390–7) WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 1. (Tennessee Valley Authority, Knoxville). 18 Aug 1971. 642p. (DOCKET-50391–7). Dep. NTIS.

Revised design parameters of the Watts Bar Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

51005 (DOCKET-50400–2) SHEARON HARRIS NUCLEAR POWER PLANT, UNITS 1, 2, 3, AND 4. Environmental Report. (Carolina Power and Light Co., Raleigh, N. C.). 7 Sep 1971. 104p. (DOCKET-50401–2; DOCKET-50402–2; DOCKET-50403–2). Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

51006 (DOCKET-50400–3) SHEARON HARRIS NUCLEAR POWER PLANT, UNITS 1, 2, 3, AND 4. Preliminary Safety Analysis Report, Vol. 1. (Carolina Power and Light Co., Raleigh, N. C.). 7 Sep 1971. 221p. (DOCKET-50401–3; DOCKET-50402–3; DOCKET-50403–3). Dep. NTIS.

General design characteristics of the Shearon Harris Power Reactor Units 1,2,3, and 4 are presented. (D.C.C.)

51007 (DOCKET-50400–4) SHEARON HARRIS NUCLEAR POWER PLANT, UNITS 1, 2, 3, AND 4. Preliminary Safety Analysis Report, Vol. 2. (Carolina Power and Light Co., Raleigh, N. C.). 7 Sep 1971. 465p. (DOCKET-50401–4; DOCKET-50402–4; DOCKET-50403–4). Dep. NTIS.

Information on the Shearon Harris Power Reactor Units 1, 2, 3, and 4 is presented under the heading of site and environment. (D.C.C.)

51008 (DOCKET-50400–5) SHEARON HARRIS NUCLEAR POWER PLANT, UNITS 1, 2, 3, AND 4. Preliminary Safety Analysis Report, Vol. 3. (Carolina Power and Light Co., Raleigh, N. C.). 7 Sep 1971. 435p. (DOCKET-50401–5; DOCKET-50402–5; DOCKET-50403–5). Dep. NTIS.

Information on the Shearon Harris Power Reactor Units 1, 2, 3, and 4 is presented under the following broad topics: reactor; reactor co-lant system; containment; and engineered safety features. (D.C.C.)

51009 (DOCKET-50400–6) SHEARON HARRIS NUCLEAR POWER PLANT, UNITS 1, 2, 3, AND 4. Preliminary Safety Analysis Report, Vol. 4. (Carolina Power and Light Co., Raleigh, N. C.). 7 Sep 1971. 400p. (DOCKET-50401–6; DOCKET-50402–6; DOCKET-50403–6). Dep. NTIS.

Information on the Shearon Harris Power Reactor Units 1, 2, 3, and 4 is presented under the following broad topics: instrumentation and control; electrical systems; auxiliary systems; steam and power conversion; waste processing system and radiation protection; conduct of operations; and initial tests and operation. (D.C.C.)

51010 (DOCKET-50400–7) SHEARON HARRIS NUCLEAR POWER PLANT, UNITS 1, 2, 3, AND 4. Preliminary Safety Analysis Report, Vol. 5. (Carolina Power and Light Co., Raleigh, N. C.). 7 Sep 1971. 400p. (DOCKET-50401–7; DOCKET-50402–7; DOCKET-50403–7). Dep. NTIS.

Information on the Shearon Harris Power Reactor Units 1, 2, 3, and 4 is presented under the following headings: safety analysis; and proposed technical specifications. (D.C.C.)

51011 (JAERI–13647) STUDIES ON RADIOACTIVE IODINE BEHAVIOR RELEASED IN M.C.A. AND H.A. OF JPDR-II AND FILTER FOR RADIOACTIVE IODINE. Futamura, Yoshiaki; Ohtsuka, Ryoichi (Japan Atomic Energy Research Inst., Tokai). Jul 1969. 41p. NTIS (U. S. Sales Only).

Time-dependent amounts of organic and in-organic radioactive iodine released from fuel, reactor vessel and reactor enclosure into the surroundings are calculated in the event of maximum credible accident and hypothetical accident of JPDR-II. Impregnated charcoal filter removing organic and radioactive iodine is investigated. (auth) (Japan)

51012 (SGAE-RT–40/1971) COVERAGE OF THE ENVIRONMENTAL INFLUENCE AS A RESULT OF THE FIRST AUSTRIAN NUCLEAR POWER PLANT. Schlosser, K.; Oszuszky, F. J. P. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Institut fuer Reaktortechnik). Mar 1971. 76p. (In German). Dep. NTIS (U. S. Sales Only).

Surveyed are reactor-produced radioactivity as well as methods for concentration and solidification of radioactive waste. Criteria and installations for disposal sites are discussed in detail. Permissible emission values into the environment are discussed for radioactive material and for heat in comparison with environmental pollution by other energy sources. Safety and risk of nuclear power plants were compared with general risks to modern man. Conclusions contain specific standards applicable to Austria. (97 references) (tr-auth)

51013 (TID–25774) NEED FOR BETTER INFORMATION OF EFFECTS OF COASTAL REACTORS. Folsom, T. R. (Scripps Institution of Oceanography, La Jolla, Calif.). 15 Mar 1971; Revised 15 Jul 1971. 16p. Dep. NTIS.

An example is given of information that has been presented to a water quality control board by a typical "investor owned" power

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company. An inspection of the San Onofre Power Reactor Unit 1 effluents shows at least one nuclide has accumulated in at least two species. A simple calculation suggests that the much larger amounts of tritium coming from this plant probably have already altered large areas of the coastal ocean measurably. (auth)

51014 RISK ESTIMATE FOR AN URBAN-SITED REACTOR. Otway, Harry J.; Lohrding, Ronald K.; Battat, Morris E. (Los Alamos Scientific Lab., N. Mex.). Nucl. Technol.; 12: No. 2, 173-84(Oct 1971).

A method for estimating the risk from reactor installations is presented and applied to the Omega West Reactor, an 8-MW(t) research reactor at Los Alamos, New Mexico. The method, which considers both accident probabilities and the probability of various wind and weather conditions, estimates individual risk as a function of direction and distance from the reactor and estimates the total detriment to the community as the consequence of reactor accidents. The somatic risk due to thyroid carcinoma from ^{131}I uptake, the somatic risks of leukemia and other neoplasmas from whole-body irradiation, the genetic risk, and non-specific life shortening were considered. The individual somatic risk at the nearest habitation was found to be 5×10^{-10}/yr and the total detriment to the community (all the above risks summed over the total population) was 4.5×10^{-4} deaths per year of reactor operation. The statistical treatment of reactor operating history and test data to obtain reliability estimates is outlined. The results of this study are compared with those from analysis of a 3200-MW(t) pressurized water reactor. (23 references) (auth)

51015 FOUR YEARS OF OPERATING EXPERIENCE WITH SAN ONOFRE TECHNICAL SPECIFICATIONS. Ortega, O. J. (Southern California Edison Co., Los Angeles). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 2-3(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51016 SPECIAL CONSIDERATIONS INVOLVED IN DEVELOPMENT OF TECHNICAL SPECIFICATIONS FOR THE HTGR. Ross, S. R. (Public Serive Co. of Colorado, Denver); Waage, J. M. Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 3-4(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51017 REACTOR PRIMARY CONTAINMENT CONTINUOUS LEAK MONITORING AND CLASS A TESTING EXPERIENCE. Tarnuzzer, Edmund C. (Yankee Atomic Electric Co., Westboro, Mass.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 14-15(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51018 PREOPERATIONAL MEASUREMENT OF ENVIRONMENTAL GAMMA RAYS AT THE MONTICELLO SITE WITH A CONTINUUM SPECTROMETER. Gold, Raymond (Argonne National Lab., Ill.); Strash, Alfred M. Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 41-2(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51019 CRYOGENIC ADSORPTION SYSTEMS FOR RADIOACTIVE GAS CLEANUP. Gitterman, M.; Goodjohn, A. J. (Gulf General Atomic Co., San Diego, Calif.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 42-3(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51020 FLOW OF WASTE HEAT FROM THERMAL ELECTRICITY PRODUCTION. Christensen, Joergen (Aktiebolaget Atomenergi, Stockholm). pp 207-17 of Nordisk Hydrologisk Konferens, Stockholm, 17-29 Aug 1970. Volym 1. Lund, Sweden; Nordic Association for Hydrology (1970). (CONF-700842-1).

From Nordic Hydrological conference; Stockholm, Sweden (27 Aug 1970).

The cooling/electricity power ratio for a thermal power plant may be expressed as a function of the thermal efficiency defined in a suitable way. The ratio varies considerably for different types of plant. The flow of waste heat from thermal electricity production in the Nordic countries anno 1980 is assessed to be 22 GW. The waste heat flow to the world's hydrosphere today is very small by oceanographic standards, but its effects may soon become discernible. The Baltic Sea and Sweden are mentioned in particular. 11 references. (auth)

51021 THERMAL POWER STATIONS AND ECOLOGY. Montanus, Klaus; Kuenstle, Konrad (Kraftwerk Union AG, Frankfurt am Main). At. Strom; 17: No. 5, 84-6(May 1971). (In German).

The problem of pollution of the environment has been the subject of public discussions, especially in the last two years. Since power stations may have an effect on their environment, ecological points of view are of importance in their construction and operation. 9 references. (auth)

51022 HSST PROGRAM. Witt, F. J. (Oak Ridge National Lab., Tenn.). Power Eng.; 75: No. 7, 46-8(Jul 1971).

A brief description is given of the Heavy Section Steel Technology program, which is concerned with safety assessments of PWR and BWR pressure vessels. The influences of heat treatment, strain rate, irradiation, etc., on the ductility and fracture of pressure-vessel steels are discussed. Results of dynamic tear tests, compact tension tests, and drop weight tests are summarized, and other tests under way are reported. (D.L.C.)

51023 ENVIRONMENTAL REPORTS AND NEW POWER PLANT SCHEDULES. Hartman, R. M. Pub. Util. Fortn.; 88: No. 2, 13-22(22 Jul 1971).

The provisions of the U.S. National Environmental Policy Act of 1969 and their effects on electric utility power plant construction and operation are discussed. Some of the problems in assuring compliance with these provisions for nuclear power plant licensing are examined. (H.D.R.)

Steam and Power Conversion Systems

51024 (JAERI-13509) TURBINE GENERATOR: REFERENCES FOR THE JPDR OPERATION. Mori, K. (Japan Atomic Energy Research Inst., Tokai). Mar 1969. 109p. NTIS (U. S. Sales Only).

The manual Turbine generator—for JPDR-operation reference was prepared to help the personnel in operation and maintenance of the JPDR. The components and other equipment of the turbine generator are described. The procedures of its operation, the associated problems, and the various tests and inspections on the turbine generator are explained. Theories and fundamentals concerning synchronous machines are given. (Japan)

51025 PERFORMANCE OF ENRICO FERMI MODIFIED STEAM GENERATORS. Ford, J. A. (Atomic Power Development Associates, Inc., Detroit); Iguchi, T.; Olson, W. R.; Tashimo, M. Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 17-18(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

Power Reactor Development

Refer also to abstracts 49343, 49371, 49424, 49452, 49505, and 49573.

51026 (ANL-7845) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, JULY 1971. (Argonne National Lab., Ill.). 20 Aug 1971. Contract W-31-109-eng-38. 160p. Dep. NTIS.

Highlights of project activities for July 1971 are summarized. The EBR-2 operations, fuels and materials studies, engineering development, and testing activities are reported. Heat transfer and fluid flow studies for LMFBR safety aspects are summarized. The development of FFTF instrumentation is reviewed. Sodium interactions with metals are studied. Performance characteristics of LMFBR fuel elements and fuel element cladding are described. Reprocessing methods for LMFBR fuels are discussed. Fast reactor physics measurements are presented for the ZPPR and ZPR-6 studies. LMFBR safety studies are described. TREAT operations are reviewed. Thermal discharge effects on Lake Michigan are studied. (D.C.C.)

51027 (EUR-4363) STEEL PRESSURE VESSELS AND UNIT POWER OF PRESSURIZED HEAVY WATER REACTORS. Huber, B. (European Communities, Brussels (Belgium). Commission). 1970. 21p. (In French). NTIS (U. S. Sales Only).

Various factors which may limit the practical size of steel pressure vessels are surveyed. The maximum unit power attainable is estimated for heavy water reactors in which the reactor vessel contains the pressure of the primary cooling circuit. 13 references. (auth) (EURATOM)

51028 (EURFNR-867) FAST BREEDER PROJECT. Third Quarterly Report, 1970. Hueper, R.; (and others) (Kernforschungszentrum, Karlsruhe (West Germany)). Translation of report KFK-1270/3. 168p. (EUR-4571). Dep. NTIS.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

The work done on fuel rod design, preparation and irradiation of

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fuel rods, reactor and rod material development and study, corrosion studies, coolant analyses, fuel cycles, reactor theory, safety of fast reactors, instrumentation and signal propagation for core monitoring, consequences of reactor incidents on the environment and activity release, sodium technology studies, thermodynamic and hydrodynamic research in gas and steam, reactor design studies, and the fast high flux test reactor FR 3 is reported in detail. (J.S.R.)

51029 (JAERI-13620) DEVELOPMENT OF THE GAS COOLED REACTORS. Muto, Yasushi (Japan Atomic Energy Research Inst., Tokai). Jun 1969. 54p. NTIS (U. S. Sales Only).

A literature survey of the various kinds of gas cooled reactors is presented the feasibility of the gas cooled fast breeder is assessed. The region of the survey extends from the Magnox reactor, the AGR and the helium gas cooled reactor which are under operation or under construction to the reference designs of the gas cooled fast reactors. The description is undertaken with the historical development of gas cooled reactors so that efforts which were devoted to power cost reduction and the results of improvements and transformation of the design limits are shown. As the result of this study, the logical development from Magnox clad natural uranium metallic fuel to stainless steel clad oxide fuel to pyrolytic carbon coated carbide fuel becomes apparent. The experience about the fuel of the sodium cooled fast reactor and also the plant of the gas cooled thermal reactor contribute to the design of the gas cooled fast reactor. In the design of the sodium cooled fast reactor, sodium oxidization, purification, radioactivation and fire are the most important design factors, but in the design of the gas cooled reactor, helium or carbon dioxide technology is a less important factor and the high rating fuel design, the core design under high temperature and high coolant velocity and the safety assessment of the depressurization owing to loss of coolant are the most severe problems. Following this initial survey study, the thermal design analysis of both the fuel and the plant, the precise survey study containing the plant equipment of the Magnox reactor, the AGR and the helium gas cooled reactor, and the feasibility study containing the safety analysis of the fast reactor are undertaken. (auth) (Japan)

51030 (NAA-SR-12492) ANNUAL TECHNICAL PROGRESS REPORT, AEC UNCLASSIFIED PROGRAMS, FISCAL YEAR 1967. (Atomics International, Canoga Park, Calif.). 30 Jun 1971. Contract AT(04-3)-701. 302p. Dep. NTIS.

BERYLLIUM OXIDES—radiation effects on single crystals of, high temperature, (E)
CHROMOSOMES—radiation chemistry of, (E/T)
FISSION PRODUCTS—distribution in sodium cooled reactor cooling systems, (E/T)
—release in coolant fires in
FUSED SALTS—chemical properties of, high temperature
GRAPHITE—preparation of single crystals of, (E)
HALLAM POWER REACTOR—retirement of
LIQUID METAL FAST BREEDER REACTOR—safety of, effects of sodium boiling on, (E/T)
METALS—electronic structure of, (E/T)
NEUTRON CROSS SECTIONS—data production and evaluation for reactor physics calculations
ORGANIC COMPOUNDS—radiolysis of, physicochemical processes in, (E/T)
PIQUA POWER REACTOR—fuel elements for, evaluation of performance of
REACTIVITY—Doppler coefficient measurements in fast spectra
REACTOR FUEL ELEMENTS—cladding for sodium cooled, development of stainless steel
—evaluation of uranium oxide (UO_2)-tungsten, for fast reactor
REACTOR FUELS—radiation effects on creep and swelling of metal, (E/T)
REACTORS, FAST—development of sodium cooled, during July 1, 1966 to June 30, 1967
—coolant combustion in sodium cooled, release of fission products from, (E/T)
—neutron flux distribution in, methods for determination of, (T)
—neutron spectra in, effects of coolant and structural materials on, (E/T)
—cooling system of sodium cooled, distribution of fission products in, (E/T)
REACTORS, LIQUID METAL COOLED—cooling system of sodium cooled, distribution of fission products in, (E/T)
—coolant combustion in sodium cooled, release of fission products from, (E/T)
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REACTORS, ORGANIC COOLED—coolant combustion in, heat and fission product release from, (E/T)
SODIUM—combustion in fast reactors, release of fission products in, (E/T)
—preparation for use in reactor cooling systems
—solvent properties for metals and nonmetals
SODIUM REACTOR EXPERIMENT—retirement of
SOLIDS—radiation effects on crystalline, (E/T)
STAINLESS STEEL—properties for use as sodium cooled reactor fuel element cladding
TUNGSTEN ALLOYS—UC-W, properties for use as fast breeder reactor fuel
URANIUM CARBIDES—UC-W, properties for use as fast breeder reactor fuel (H.D.R.)

51031 (RCN-143) FAST REACTOR PROGRAMME. Third Quarter 1970 Progress Report. Hoekstra, E. K. (comp.) (Reactor Centrum Nederland, Petten). Mar 1971. 83p. Dep. NTIS (U. S. Sales Only).

Fast reactor physics programs are described. Operations of the STEK Assembly are reviewed. Performance limits for stainless steel clad UO_2 fuel pins are analyzed. Fast neutron radiation effects on the tensile properties of Type 304L stainless steel are measured. The characteristics of Na aerosols in nitrogen are studied. Sodium boiling conditions in fast reactors are described. 7 references. (D.C.C.)

51032 ATOMICS INTERNATIONAL DESIGN. Stoker, D. J.; Balent, R. (Atomics International, Canoga Park, Calif.). Combustion; 42: No. 12, 61-3 (Jun 1971).

Design parameters for a 500 MW(e) LMFBR demonstration plant from Atomics International are presented. 8 references. (D.C.C.)

51033 ATOMICS INTERNATIONAL LMFBR DEMONSTRATION PLANT. Beeley, R. J.; Ash, E. B. (Atomics International, Canoga Park, Calif.). Combustion; 42: No. 12, 59-61 (Jun 1971).

Design parameters for a LMFBR demonstration plant from Atomics International are presented. (D.C.C.)

51034 WESTINGHOUSE LIQUID METAL FAST BREEDER REACTOR DEMONSTRATION PLANT DESIGN. Jacobi, W. M. Contract AT(30-1)-4200. Combustion; 42: No. 12, 49-58 (Jun 1971).

Design parameters for a LMFBR demonstration plant from Westinghouse are presented. (D.C.C.)

51035 DESCRIPTION OF 350 MWe LIQUID METAL FAST BREEDER DEMONSTRATION PLANT. Fidrych, L. F. (General Electric Co.; Sunnyvale, Calif.). Combustion; 42: No. 12, 43-8 (Jun 1971).

Design parameters for a 350 MW(e) LMFBR demonstration plant from General Electric are presented. (D.C.C.)

51036 NUCLEAR REACTORS. Wolff, Paul Heinz Walter; Joyce, Alfred John (to British Nuclear Design and Construction Ltd.). British Patent 1,243,374. 18 Aug 1971. Filed 5 Mar 1968.

Reference is made to gas-cooled graphite-moderated reactors employing fuel particles contained in sealed SiC tubes, and in which the graphite blocks are readily removable from the core for replacement of the fuel elements and/or the blocks. The blocks of each stack are preferably provided with a central fuel element channel in which is supported a central guide tube with the fuel elements arranged there around; this guide tube is provided with a grab for removal of the blocks. The fuel may consist of UO_2 or UC or other suitable fuel materials in the form of coated particles. An advanced gas-cooled reactor employing this arrangement is described in detail. (UK)

51037 IMPROVEMENTS IN OR RELATING TO POWER PLANT. (to Babcock and Wilcox Ltd.). British Patent 1,238,352. 7 Jul 1971. Priority date 6 Oct 1967, France.

REACTORS, POWER—design with reheater stage and steam turbine driven feedwater pump
REACTORS, WATER COOLED—design with reheater stage and steam turbine driven feedwater pump (H.D.R.)

51038 GAS TURBINE PLANTS. Schmidt, David (to Sulzer Brothers Ltd.). British Patent 1,237,559. 30 Jun 1971. Priority date 8 Nov 1967, Switzerland.

REACTORS, GAS COOLED—design with direct cycle turbine and means for load following
TURBINES—design of direct cycle gas, for coupling to gas cooled reactors (H.D.R.)

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Kinetics and Dynamics

Refer also to abstract 51230.

51039 (ANL–7769) FAST-REACTOR KINETICS: THE QX1 CODE. Meneley, D. A.; Ott, K. O.; Wiener, E. S. (Argonne National Lab., Ill.). Mar 1971. Contract W-31-109-eng-38. 96p. Dep. NTIS.

The QX1 code (Quasistatic Excursion Code, 1-dimensional) is described. The code solves the transient, one-dimensional, multigroup diffusion equations by factorizing the total flux into a time-dependent amplitude function and a space-energy-time-dependent shape function. The capability of modifying resonance cross sections as a function of fuel temperature to account for Doppler feedback has been included. The model was specifically designed for extension to two space dimensions and for inclusion of further feedback algorithms to describe thermal-hydraulic and other effects. (26 references) (auth)

51040 (BAW–3647–21) PHYSICS VERIFICATION PROGRAM, PART III, TASKS 5 AND 6. Quarterly Technical Report, January–March 1971. Baldwin, M. N.; Fairburn, G. T. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Aug 1971. Contract AT(30-1)-3647. 48p. Dep. NTIS.

An experimental program was conducted to correlate the response of all-solid, self-powered, in-core neutron flux detectors to the power density profiles of a critical assembly. The experimental assembly, a water-moderated, slightly enriched UO_2 lattice perturbed by Ag–In–Cd poison pins and dissolved boric acid, is arranged to mock up the fuel elements of a commercial pressurized water reactor. These test results, obtained during the first quarter of 1971, will serve to check analytical techniques for relating detector signals and power profiles in commercial power reactors. The plutonium lattice experiments were conducted to obtain data for verification of the analytical methods and models developed for the design of water-moderated plutonium recycle cores. Because of the great expense of performing conventional critical experiments with a variety of fuels, the program is restricted to "small-lattice experiments." The system is tailored to provide a critical assembly with a small central test region and a nearly flat flux and asymptotic spectrum. The test region is incrementally poisoned with boric acid until a void substitution yields a null reactivity change. This gives a precise measure of the boron concentration required to reduce to unity the infinite-medium multiplication factor of the test lattice. Comparing this number with the corresponding analytical prediction yields a sensitive and direct check on the adequacy of the theoretical procedures. Various other measurements were also taken on the poisoned and unpoisoned test lattice. (auth)

51041 (BNL–15746(Vol.1)) COMPILATION OF FAST REACTOR EXPERIMENTS. Palmedo, Philip F. (ed.) (Brookhaven National Lab., Upton, N. Y.). 1 Jun 1971. Contract AT(30-1)-16. 318p. Dep. NTIS.

Presented in two volumes is a compilation of those fast reactor experiments which, by virtue of their accuracy, lack of ambiguity, and the small number of material components involved, are of potential use in testing analytical techniques and cross sections. The specific purposes of the compilation are to provide up-dated and corrected data from experiments that may have been only partially or incorrectly reported in the literature and to provide a convenient means of access to particular types of experimental information. Only those experiments which can conceivably be used to test cross sections or calculational methods are considered. Thus, complex assemblies or mock-up experiments are only briefly described, if included at all. Similarly, not all existing examples of each type of individual measurement are included. The criteria rule out, for example, most measurements of control rod worth which are commonly made for operational reasons. This first part of the compilation includes only data from three facilities operated by the Argonne National Laboratory: ZPR-3 (through Assembly 48A), ZPR-6 (through Assembly 6) and ZPR-9 (through Assembly 24A). (auth)

51042 (BNL–15746(Vol.2)) COMPILATION OF FAST REACTOR EXPERIMENTS. Palmedo, Philip F. (ed.) (Brookhaven National Lab., Upton, N. Y.). 1 Jun 1971. Contract AT(30-1)-16. 359p. Dep. NTIS.

Data from fast reactor physics experiments in the ZPR-3, ZPR-6, and ZPR-9 critical assemblies are presented. (H.D.R.)

51043 (JAERI–13505) VARIATIONS IN NEUTRONIC CHARACTERISTICS OF A LARGE FAST CONVERTER ALONG WITH BURNUP. Nozawa, Masao (Japan Atomic Energy Research Inst., Tokai); Yamashita, Shizuo; (and others). Mar 1969. 40p. NTIS (U. S. Sales Only).

Variations in neutronic characteristics of a pancake-shaped 1000 MW(e) sodium-cooled fast converter are obtained from burnup calculations based on a one dimensional slab model approximation, when the converter is operated with specific refueling schemes. The core of the converter has enriched uranium dioxide pellets as fuel instead of plutonium-uranium dioxide pellets and beryllia pellets in the core of the pancake-shaped 1000 MW(e) sodium-cooled fast breeder. The initial loading fuel of ^{235}U enrichments of 22.3% and 25.8% is loaded in the inner and outer cores respectively, and the total amount of ^{235}U loaded in the core is 3.74 ton, for the sake that the converter has the same reactivity as the fast breeder and the power distribution in the inner core is flat. The converter is assumed to be operated with a refueling scheme of six-month refueling cycle and four-batch loading in both zone of core. The burnup calculations for the simulation of operation are carried out by the one dimensional slab model approximation. The equilibrium state is soon reached after the start of operation, when the refueling fuel of ^{235}U enrichment of 26.3% and 30.4% is used for the inner and outer cores, respectively. The conversion ratio in the equilibrium state is nearly equal to about 0.78 in the initial state. Sodium void effect of -0.82 $\Delta k/k\%$ in the initial state will rise to -0.26 $\Delta k/k\%$ in the equilibrium state, with sodium completely removed from the core. Sodium void effects in the initial state have always the negative values for the converter having every void enclosing the center plane of the core, while the effect in the equilibrium state has a positive worst value of $+0.1$ $\Delta k/k\%$ at the operation temperature. Doppler coefficient of -0.00318 $T \cdot dk/dT$ in the initial state increases to -0.00297 $T \cdot dk/dT$ in the equilibrium state with sodium. (auth) (Japan)

51044 (JAERI–13590) NEUTRONIC CHARACTERISTICS OF A LARGE FAST CONVERTER. 4. Nozawa, Masao (Japan Atomic Energy Research Inst., Tokai); Yamashita, Shizuo; (and others). Jun 1969. 28p. NTIS (U. S. Sales Only).

Calculations are carried out for neutronic characteristics of a 1000 MW(e) sodium-cooled fast converter in an initial state by using a diffusion approximation with the ABN set. The core of the fast converter is fueled with enriched UC pellets. Enrichments in the inner and outer cores are 14.8% and 22.8%, respectively. The initial loading of ^{235}U in the core is 1830 kg. The total breeding ratio is about 1. The sodium void effect is -3.24 $\Delta k/k\%$ without sodium in the core. This effect on the fast converter is better than the reference fast breeder with $+0.232$ $\Delta k/k\%$. The average Doppler coefficient is -0.00321 $T \cdot dk/dT$ with sodium completely removed from the core. (auth) (Japan)

51045 (JAERI–13699) EFFECT OF PHOTO-NEUTRON ON β OF PRESSURE TUBE TYPE DEUTERIUM WATER REACTOR. Kaneko, Yoshihiko (Japan Atomic Energy Research Inst., Tokai). Aug 1969. 6p. NTIS (U. S. Sales Only).

An effect of the photo-nuclear reaction on the delayed neutron fraction β of a pressure-tube type deuterium water reactor is evaluated under some simplified assumptions. A conclusion is obtained that the fraction of the hard gamma-rays emitted from the fission products to reach the deuterium water region is only about 30% due to the electron pair creation process in the 28 fuel rods. This result suggests that a precise experimental or theoretical study must be made for the phenomena of gamma-ray transmission from the region of the cluster fuel to that of the deuterium water. (auth) (Japan)

51046 (JAERI–13724) LATTICE AND CORE PERFORMANCES OF HEAVYWATER MODERATED POWER REACTORS WITH FUEL BURNUP. Yasikawa, Shigeru (Japan Atomic Energy Research Inst., Tokai). Oct 1969. 318p. NTIS (U. S. Sales Only).

Extensive lattice and core performances with fuel burnup were studied for heavy–water moderated power reactors. Several concepts of reactor cores are summarized and their distinctive features are illustrated. The burnup characteristics on a reactivity change, a local power peaking, a lattice fuel burnup, and reactivity coefficients are analyzed for the lattices with uranium, plutonium, and thorium fuel loadings. The core nuclear performances under the several fuel managements are manifested. These are the batch fueling, the radial out-in and in-out fuelings, the axial bi-directional fueling, the chess board fueling, and the axial shuffling. The analytical method for processing the continuous fueling such as the out-in and in-out fuelings and the axial bi-directional fueling are explained in detail. The core and the fuel cycle characteristics of the plutonium self-supplying reactor are summarized, and its potential use in the future reactor system of Japan is investigated. The installed effects of the heavy water moderated reactors are analyzed from the long range fuel cycle of Japan. Especially, the natural uranium requirement and the optimum reactor installation are extensively

studied when the heavy water reactors are installed. (auth) (Japan)

51047 (JUL-746-RG) DEVELOPMENT OF A SPECTRAL PROGRAM FOR SPHERICAL FUEL ELEMENTS AS WELL AS INVESTIGATION OF THE SIZE AND INFLUENCE OF THE MODERATOR COEFFICIENT IN HIGH-TEMPERATURE REACTORS. Bonka, Hans (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Apr 1971. 180p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Technische Hochschule, Aachen, Ger.

A spectral program for spherical fuel elements was developed for the energy range from 5×10^{-4} to 2.05 eV. In addition, the burnup within this range was calculated. The spectral program was applied to the behavior of temperature coefficients in high-temperature reactors. With the spectral program, neutron flux in fuel cells can be computed for 96 energy groups and for 15 points of reference by means of an integral transport equation, isotope scattering, and isotope flux. Beyond 2.05 eV, a constant flux was assumed. Studies of temperature coefficients showed a very strong enhancement through ^{135}Xe, ^{239}Pu, ^{241}Pu, and ^{233}U. The temperature coefficient could be decreased only through ^{167}Er and, in thorium high-temperature reactors, also through ^{103}Rh. Reduction of the moderation ratio proved to be the best approach. (78 references) (tr-auth)

51048 (TRG-Report-2133) CALCULATIONS FOR A LARGE FAST REACTOR: A COMPARISON OF RESULTS ORGANISED BY THE INTERNATIONAL ATOMIC ENERGY AGENCY. Baker, A. R.; Hammond, A. D. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1971. 105p. Dep. NTIS (U. S. Sales Only). UK 70p.

An international comparison of calculations for a typical large sodium-cooled fast reactor has been organized under the auspices of the International Working Group on Fast Reactors of the International Atomic Energy Agency. The prime purpose of the comparison was to investigate the uncertainty in critical mass and breeding gain due to the current uncertainty in alpha for ^{239}Pu. The simple model chosen for the calculation had a spherical core of volume 2.5 m^3 with a blanket 0.457 m thick surrounded by void. Seventeen contributions were received from twelve different organizations. The principal contributor to the root mean square (RMS) deviation about the mean of 0.012 in k_{eff} for Case A, in whose core the only heavy nuclides were ^{239}Pu and ^{238}U, was the calculated value of σ_{c8}/σ_{f9}, due to differing choices of group constants. The principal contributor to the RMS deviation about the mean of 0.04 in internal breeding gain, G_I, was the calculated value of α_9, due to differing choices of group constants. The uncertainty in external breeding was less important. Case B enabled the effect of fission products to be assessed: fission products representing 10% burnup negligibly altered the RMS deviation. From Case C and from equivalent worths quoted, it was shown that the data for ^{240}Pu and ^{241}Pu may appreciably increase the uncertainty in k_{eff} if plutonium containing a high proportion of higher isotopes than ^{239}Pu were to be used in the core. It is shown that approximations in the recommended method of calculation do not invalidate the conclusions concerning nuclear data. The features studied were: different methods of producing a coarse-group data set from a fine-group library; a doubled space mesh; a double-thickness blanket; and the use of transport theory instead of diffusion theory. 15 references. (auth)

51049 NEUTRON FLUCTUATION IN POWER REACTORS. Morishima, Nobuhiro (Kyoto Univ.). Nippon Genshiryoku Gakkai Rochuseishi Kenkyu Senmon Iinkai Hokoku; No. 25, 29-44 (Oct 1969). (In Japanese).

The neutron fluctuation in a low power light water reactor is analyzed. The density change of water in a light water reactor is an important factor of performance analysis. The dependence of temperature coefficients on moderator temperature is investigated. Energy transfer equations are introduced where a reactor is considered to be a thermodynamically open system. The internal energy of the system depending on two physical constants and the number of components, and the chemical potential are taken into consideration. These equations are the equations of temperature and density in a lumped system. The randomness due to water flow is considered in heat transfer by convection, and a Langevin equation is assumed. The neutron fluctuation of a reactor is described as a Markoffian random process with the above consideration. The frequency spectra of neutron fluctuation are obtained as a quasi-linear process. The numerical analysis of a 100 kV light water reactor is carried out. Figures show the result of the analysis. Theoretical transfer functions, theoretical input noise spectra and power spectral density are shown in the figures. (Japan)

51050 ANALYSIS OF DYNAMIC CHARACTERISTICS OF A PWR NUCLEAR PLANT. Obinata, Sumiko; Koyama, Shigeo; Wakamatsu, Seiji (Electrotechnical Lab., Tokyo). Denshi Gijutsu Sogo Kenkyusho Iho; 34: No. 8, 619-38(Aug 1970). (In Japanese).

The dynamic characteristics of the Yankee-type PWR plants have been analyzed from the standpoint of the power system through the use of a digital computer. The transient behavior of plant parameters such as the reactivity, the neutron density and the temperatures of fuel and coolant are given in the two cases of step and periodic changes of the power demand, with rod-control and without control. The effects of the neutron life time and the number of delayed neutrons, and the validity of the prompt jump approximation are also discussed in regard to plant parameters. It is confirmed that it is possible to improve the behavior of the plant parameters remarkably by using a suitable rod-control system. (auth) (Japan)

Control Systems

Refer also to abstracts 49506 and 51050.

51051 (JAERI-13501) SPACE-TIME BURN-UP OF AN ABSORBING SLAB. Takeuchi, Eiji; Takeda, Renzo (Japan Atomic Energy Research Inst., Tokai). Apr 1969. 36p. NTIS (U. S. Sales Only).

The space and time dependent number density changes of absorbing material in slab geometry were analyzed. The neutron flux is calculated by solving the transport equation, and with this flux, the absorption rate of neutrons, that is, the number density change of boron, is obtained region wise, and the transport equation is solved for the next time step. The changes of the region wise number densities of the absorbing material, the boundary conditions and the spectra of an absorbing slab are described. This analysis is applied to the evaluation of the time dependent worth changes of the JPDR type cruciformed control rod. (auth) (Japan)

51052 (JAERI-13516) MOCK UP EXPERIMENT OF JFER CONTROL ROD IN FCA III-1. Hirakawa, Naohiro (Japan Atomic Energy Research Inst., Tokai). Apr 1969. 18p. NTIS (U. S. Sales Only).

An experiment was carried out in FCA III-1 to obtain the reactivity effect of B_4C filled drawers which simulated the control rod of phase 2 design study of JFER. Natural boron B_4C powder filled stainless steel cans (5.1 cm × 5.1 cm × 0.6 cm) were used in the experiment. By changing the number of B_4C filled cans in the drawer (5.1 cm × 5.1 cm × 30.5 cm), reactivity effect as a function of B_4C quantity was measured. When the natural uranium metal blanket of III-1 was replaced by the materials which simulate the oxide blanket of JFER, the reactivity effect of B_4C drawer increased and also self shielding effect of B_4C was observed. Also reactivity effect of B_4C drawer according to the change in position in the core and the interference effect of two B_4C drawers was measured. These results were compared with those of one dimensional diffusion calculation and it was found that the calculated values were about 30 percent smaller than the experimental ones when the self shielding effect does not exist. Also several points to take into account in the scheduled JFER control rod mockup experiment with Pu loaded core are discussed. (auth) (Japan)

51053 (JAERI-13537) STABILITY ANALYSES ON THE PLANT OF FBR INCLUDING CONTROL SYSTEMS. SSK-II. Ezaki, Masahiro (Japan Atomic Energy Research Inst., Tokai). May 1969. 48p. NTIS (U. S. Sales Only).

Stability analyses on FBR must be done taking account of the influence of external cooling systems, control systems and detector characteristics as well as core characteristics. The code SSK-II is introduced taking account of the influence of those characteristics, and it is possible to evaluate the stability of atomic power plants and to estimate optimum parameters of control systems and capacity of cooling systems from the point of view of transient phenomena. Some analyses about "JFBR Secondary Conceptual Design" were examined and the results are described. (auth) (Japan)

51054 MEASUREMENT OF THE LOCAL RADIATION FIELD IN A NUCLEAR REACTOR BY MICROWAVE INTERFEROMETRIC TECHNIQUES. Bhattacharya, A. K.; Verdeyen, J. T.; Adler, F. T.; Goldstein, L. (Univ. of Illinois, Urbana). Nucl. Instrum. Methods; 95: No. 2, 313-25(1971).

A study of the radiation-field intensity in the core of a pulsed nuclear reactor by means of microwave propagation through an

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appropriately chosen noble gas placed within the reactor is reported. It is shown that the microwave propagation techniques are capable of measuring the reactor power, the local radiation flux, and the dynamic reactor response instantaneously over a wide range of power levels. The technique is virtually unlimited in its ability to follow fast transients in reactor power. The technique was used to measure reactor power from 40 kW to 560 MW. It was also used to measure the spatial gamma flux profile in the core of Triga Mark II reactor. It is shown that the technique is suitable for measurements of both high (>10^{10} R/h) and low (≈10^4 R/h) gamma dose rates. 17 references. (auth)

51055 POWER DISTRIBUTION CONTROL USING EXCORE DETECTORS. Nath, R. J. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 6-7(1971).
From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51056 APPLICATION OF A MEDIUM-SCALE DIGITAL COMPUTER TO OPERATIONAL SUPPORT OF EBR-II. Tucker, K. D.; Laird, E. W.; Hyndman, R. W. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 33(1971).
From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51057 COMPUTER-AIDED EXPERIMENTAL SUPPORT. Tuck, M. R.; Engen, I. A.; Hyndman, R. W. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 34(1971).
From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51058 INSTRUMENTATION FOR NUCLEAR PLANT. Smith, P. V. At. Energy Aust.; 14: No. 2, 28-37(Apr 1971).

Overall instrumentation requirements for a large scale nuclear power plant are reviewed with particular reference to operational and design aspects. Examples are predominantly taken from water reactor technology, but are generally relatable to other reactor types. Considerations of importance to the plant operator and upon which instrumentation may have significant effect include automated protection for the plant to safeguard the high capital investment, plant personnel and general public; ease of control—a simplified PWR control system is illustrated; relevant information display on the state of the plant to operators; avoidance of unnecessary disturbance to the system through spurious tripping; ease of maintenance; and maximum availability to enable use of high-capital-cost plant to the maximum practicable extent. Nuclear instrumentation is considered. Principles of neutron detectors, mean current ionization chambers and pulse counter chambers are outlined, and attention is given to power measurement range and in-core flux measurements. (Australia)

51059 IMPROVED SYSTEM FOR OPERATING A BOILING WATER REACTOR-STEAM TURBINE PLANT. (to Westinghouse Electric Corp.). British Patent 1,238,279. 7 Jul 1971. Priority date 26 Nov 1968, United States.

REACTORS, BOILING—turbine speed control system for, design of load-following
REACTORS, POWER—turbine speed control system for, design of load-following
TURBINES—speed content system for, design of load-following (H.D.R.)

Shielding

51060 (ORNL-TM-3538) FAST REACTOR SHIELDING ACTIVITY NO. 40 01 61, 189A NO. 10028. Monthly Progress Report, July 1971. Mynatt, F. R.; Clifford, C. E.; Gritzner, M. L.; Maerker, R. E. (Oak Ridge National Lab., Tenn.). 25 Aug 1971. 28p. Dep. NTIS.

Schedules for the experimental and analytical programs during fiscal 1972 are presented. Activities during July 1971 included: (1) transport method development for metal shields; (2) Fast Flux Test Facility design calculations; (3) Monte Carlo transport through iron; and (4) Tower Shielding Facility experiments. (H.D.R.)

51061 PROBLEMS IN THE FABRICATION AND ERECTION OF A SAFETY CONTAINMENT. Straub, H.; Ramseyer, F. Sulzer Tech. Rev.; 53: No. 1, 18-26(1971).

In addition to the principal technical data, a brief account is given of the design, fabrication, transport, erection, quality control and pressure testing of the safety containment. The technicalities have been deliberately left incomplete in order to concentrate on certain particularly interesting problems. (auth)

51062 PROBLEMS OF RADIATION SHIELDING DESIGN IN PRESSURIZED-WATER REACTOR NUCLEAR POWER PLANTS. Krueger, F. W. (VEB Kombinat Kraftwerksanlagenbau, Berlin. Vorbereitung Kernkraftwerke, Berlin). Kernenergie; 14: No. 4, 102-7(Apr 1971). (In German).

A brief review of radiation and activity situation in nuclear power plants with pressurized-water reactors is given. Starting from this, problems of optimizing the shields are discussed. Optimum make-up of the shields in auxiliary and secondary equipment is essential. It is estimated how the results of recent research in the field of radiation shielding may contribute to improve the shields in nuclear power plants with pressurized-water reactors. Studies of activity distribution in the primary coolant loop of the nuclear power plant and in its secondary installations as well as of gamma-ray streaming through laminated and irregular shields are described. 9 references. (auth)

Cooling Systems

Refer also to abstracts 49039, 49047, 49048, and 50890.

51063 (GEAP-10221-7) DEFICIENT COOLING. 7th Quarterly Progress Report, January 1–March 31, 1971. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Apr 1971. Contract AT(04-3)-189. 52p. Dep. NTIS.

During the quarter, single- and two-phase subchannel data were taken for the three unique subchannels in a nine-rod (3 × 3) calrod heater bundle. Transient flow tests were run with a one-rod heater in which the flow was quickly reduced to a low value, nearly zero, and then the original high flow reestablished after a prescribed time. This test is a simple, partial simulation of a loss-of-coolant accident. Film boiling data, taken with a ball-supported heater with annular flow, are also reported. (auth)

51064 (JAERI-13602) TRABLL: A COMPUTER CODE FOR TRANSIENT BOILING OF REACTOR COOLANT IN A SINGLE CHANNEL. Tone, Tatsuzo; Kuroi, Hideo (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment). Jun 1969. 43p. NTIS (U. S. Sales Only).

A computer code TRABLL for IBM-7044, -7090 and -360 was prepared for study of thermo-hydrodynamic characteristics in sodium cooled fast reactors including coolant boiling. The assumptions used in this code are as follows: (1) No coupling effect among multicoolant-channels is considered; (2) Homogeneous model is used for the analysis of two phase flow; (3) Temperature distribution in the fuel pin is represented by using the fundamental mode; (4) No pressure dependence of various material properties is considered. While this code has been prepared as a part of Fast Reactor Safety Assessment Code XANTHIPPY, this code alone can be used for calculating thermohydrodynamic phenomena induced by reactor power transients or plugging of a coolant channel. (auth) (Japan)

51065 (JAERI-13611) MULTI-TRABLL: A MULTI-CHANNEL COMPUTING MODEL FOR THERMO-HYDRODYNAMICAL ANALYSIS IN A LIQUID METAL COOLED FAST REACTOR. Ishikawa, Michio; Tone, Tstsuzo (Japan Atomic Energy Research Inst., Tokai). Jun 1969. 92p. NTIS (U. S. Sales Only).

Analytical insight to thermo-hydrodynamic phenomena including boiling in a liquid metal cooled fast reactor is necessary for fast reactor safety evaluation. MULTI-TRABLL, a multi-channel computing model for thermohydrodynamic phenomena in a fast reactor, is provided to analyze reactor power transients and coolant flow transients. The code was programmed to use for a part of the fast reactor kinetic code, XANTHIPPY at initial stage, however it is now modified to an independent program for the above phenomenon analysis. The MULTI-TRABLL is featured for its detailed thermo-hydrodynamic calculations based on experimental results. So far as the test run results are shown, the MULTI-TRABLL yields fairly stable solutions even at violent boiling occurrence. (auth) (Japan)

51066 (JAERI-13682) STABILITY OF NUMERICAL SOLUTIONS AND HYDRODYNAMIC CHARACTERISTICS OBTAINED WITH USE OF THE CODE MULTI-TRABLL. (Japan Atomic Energy Research Inst., Tokai). Aug 1969. 118p. NTIS (U. S. Sales Only).

Extensive test calculations were carried out by using the code MULTI-TRABLL. Stability of numerical solutions, hydrodynamic phenomena and the range of applicability of the code were investigated in detail. (auth) (Japan)

51067 (JAERI-13727) VIBRATION OF REACTOR STRUCTURE, PART 2-1. Vibration Induced by Fluid in Cross Flow. Ikushima, Tsuyoshi (Japan Atomic Energy Research Inst., Tokai). Sep 1969. 26p. NTIS (U. S. Sales Only).

A survey of the vibrational accident induced by fluid flow, a basic study of vibration induced by fluid in cross flow, and calculational examinations for vibration of JFER reactor structures are presented. From these analyses the following results are obtained: (1) The Strouhal number depends on the relative position of tubes, (2) The Strouhal number is concerned with the length of the vortex formation region, (3) The length of the vortex formation region depends on Reynolds number. At Reynolds number from 260 to 2600, the length of the vortex formation region is 2.25 to 2.5 times the tube diameter, and (4) According to the results of calculation, there is no evidence of having severe vibration in JFER reactor structures. (auth) (Japan)

51068 (JAERI-13769) RESULTS OF CYCLIC PRESSURE LOADING TEST DUE TO JPDR PRESSURE. VESSEL MODEL NO. 1. Fujimura, Tadato (Japan Atomic Energy Research Inst., Tokai). Oct 1969. 8p. NTIS (U. S. Sales Only).

The fatigue life of an actual pressure vessel is different from the fatigue life of small size laboratory specimens. These reasons are considered as follows: (1) The difference between various kinds of stresses or multiaxial stress in the actual vessel and uni-axial stress in the specimens. (2) The problems in the behavior of crack propagation according to the difference in the concentration of fracture energy. (3) The difference in effects from weld-overlay. A test program on pressure vessel models was performed. This program has the following purpose. Propagation through base metal for the case where the cladding cracks occur at the locations of highest stress in the vessel, that is the nozzles for forced circulation. (auth) (Japan)

51069 (RD/B/N-1721) INTERFACIAL PHENOMENA IN LIQUID METAL COOLED REACTOR SYSTEMS. Evans, H. E.; Watson, W. R. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Feb 1971. 27p. Dep. NTIS (U. S. Sales Only).

A survey of the interfacial effects likely to affect mass transfer and other processes in liquid metal cooled fast reactors has been made. Topics discussed include surface energy, wetting behaviour, adsorption at liquid and solid surfaces and the development of contact potentials at interfaces between dissimilar materials. The relevance of these topics to mass transfer and other processes in a LMFBR under routine and fault conditions is discussed. (41 references) (auth)

51070 (RD/B/N-1854) GAS BUBBLES IN THE PRIMARY CIRCUIT OF A SODIUM COOLED FAST REACTOR. PART 1. SIZE OF BUBBLES PRODUCED BY DISSOLVED GAS COMING OUT OF SOLUTION AND BY ENTRAINMENT. Winterton, R. H. S. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Feb 1971. 23p. Dep. NTIS (U. S. Sales Only).

Two possible origins of gas bubbles in the primary circuit liquid Na of a fast reactor are considered. The size of bubbles growing from dissolved gas on nucleation sites on the walls of the intermediate heat exchanger tubes is determined by a balance of surface tension and drag forces (the buoyancy force being negligible for full power operation). For finite contact angles a net surface tension force is obtained by allowing different contact angles upstream and downstream of the bubble. For zero contact angles the radius of the nucleating cavity is critical, and this is calculated from superheat data. The drag force is calculated from values of the drag coefficient obtained from freely rising bubbles. The bubble radius on detachment is determined by equating the two forces. The theory correctly predicts experimental results for air bubbles in water, and is then used to calculate bubbles sizes in the reactor. Bubbles may also be formed by entrainment at free surfaces. The size of the smallest bubbles entrained is shown to depend on a balance of surface tension and inertial forces. Again the theory is checked against experimental results with water, and then applied to the fast reactor. (7 references) (auth)

51071 DEPOSITION OF CORROSION PRODUCTS IN BOILING WATER SYSTEMS. Charlesworth, D. H. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Chem. Eng. Progr., Symp. Ser.; 66: No. 104, 21-30(1970).

The deposition of steel corrosion products on heated and unheated surfaces was studied in in-reactor and out-reactor boiling-water loops. Both deposition and release processes were found to be important in determining the amount of iron oxide which would accumulate on a surface. On fuel sheaths and other heat transfer surfaces, the deposit was porous and friable and, under constant conditions, quickly reached a steady amount as deposition and release rates became equal. Heat flux and iron concentration in the coolant are the prime factors which determine the steady amount. Because the porous deposit allows free access of water and steam to the underlying surface, these iron-oxide deposits offer little resistance to heat transfer. 9 references. (auth)

51072 HELIUM COOLANT CHEMISTRY AND BASIC DESIGN OF MOLECULAR SIEVE ABSORPTION PLANT. Kinsey, D. V.; Harper, Cecil (United Kingdom Atomic Energy Establishment, Winfrith, Eng.). Chem. Eng. Progr., Symp. Ser.; 66: No. 104, 50-72(1970).

Studies of the coolant chemistry of high temperature helium cooled reactors were made. These studies enable the estimation of standards for leak tightness of heat exchangers, and the requirements for helium purification. The coolant chemistry involved in these estimates is outlined. The basic design of a molecular sieve water and carbon dioxide adsorption plant for the purification of helium coolant is described. (auth)

51073 THERMAL AND RADIOLYTIC REACTIONS OF COOLANT IMPURITIES WITH GRAPHITE IN AN HTGR. Tingey, Garth L.; Giberson, Richland C.; Jenson, Evan D. (Battelle-Northwest, Richland, Wash.). Chem. Eng. Progr., Symp. Ser.; 66: No. 104, 73-80(1970).

The kinetics of the most likely reactions to occur between impurities in the coolant and the graphite in a High Temperature Gas-Cooled Reactor were studied. Both the thermal and radiation induced effects were studied and a model for predicting the rate of graphite removal and coolant concentration in a typical HTGR was developed. 13 references. (auth)

51074 COLD TRAP PERFORMANCE LIMITATIONS (A STATE-OF-THE-ART REVIEW). Hinze, Robert B. (Liquid Metal Engineering Center, Canoga Park, Calif.). Chem. Eng. Progr., Symp. Ser.; 66: No. 104, 94-106(1970).

High temperature sodium systems, such as those contemplated for use in fast-breeder, central-station nuclear reactors, require a high level of purity. The precipitation method, employing cold traps, is the most widely used of several liquid sodium purification methods. The current state-of-the-art of cold trap performance is reviewed. 36 references. (auth)

51075 HYDROGEN IN SODIUM EFFECTS, DETECTION, AND REMOVAL. Hill, Eugene F.; Coleman, John H. (Atomic Power Development Associates, Inc., Detroit). Chem. Eng. Progr., Symp. Ser.; 66: No. 104, 124-34(1970).

Power reactors and experimental loops which use sodium as a coolant have long been concerned with the effects of contaminants on the system. The state of the art with respect to the analysis, detection, and removal of hydrogen from sodium is described. Some significant effects of hydrogen on the analysis for oxygen and on the behavior of plugging meters and cold traps are reviewed. 19 references. (auth)

51076 IDENTIFICATION AND REMOVAL OF THE NOISE SOURCE IN THE EBR-II INTERMEDIATE HEAT EXCHANGER (IHX). Buschman, H. W.; Cerutti, B. C.; Clark, A. F. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 28-9(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51077 REMOVAL AND MODIFICATION OF PRIMARY SODIUM PUMP AT EBR-II. Deegan, G. E.; Perry, W. H.; Seever, R. E. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 29-30(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51078 OPEN DUCT COOLING-CONCEPT FOR THE RADIAL BLANKET REGION OF A FAST BREEDER REACTOR. Weiss, E. (Westinghouse Electric Corp., Madison, Pa.); Markley, R. A.; Battacharyya, A. Nucl. Eng. Des.; 16: No. 4, 375-86(1971).

A cooling concept for the radial blanket region of a fast breeder reactor is presented which utilizes perforated ducts surrounding the blanket fuel assemblies. The proposed concept generates a flow pattern which matches the sharp heat radial flux variation in the radial blanket effectively and therefore reduces coolant temperature gradients. Test results on coolant velocity and pressure distributions obtained on a simplified test model are given and the development of a subchannel analysis code is described, which utilizes the test results. The code has been used to calculate temperature and velocity profiles for a typical fast breeder radial blanket arrangement. The results indicate that the coolant temperature variation across the radial blanket region is reduced significantly with the open duct concept compared to a closed duct concept. For the feasibility of the concept it is important however to minimize the coolant bypass flow through the gaps between the individual fuel assemblies. 8 references. (auth)

51079 INTERNAL INSULATION OF REINFORCED CONCRETE PRESSURE VESSELS. Lakin, R. W. (Darchem Engi-

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neering Ltd., Stillington, Eng.). Nucl. Eng. Int.; 16: 337-43 (Apr 1971).

The choice of internal insulation for gas-cooled reactor pressure vessels is limited by environmental conditions and long service requirements to either stainless steel foil, or the fibre type, using alumina silicate or pure silicon fibres. Comparisons are made between the two types from the aspects of heat transport, compatibility with coolant and with fuel elements, and resistance to acoustic vibration. (UK)

51080 APPLICATION OF THREE DIMENSIONAL FINITE ELEMENTS TO THE ANALYSIS OF PODDED BOILER TYPE PRETRESSED CONCRETE PRESSURE VESSELS. Carmichael, G. D. T. (Central Electricity Generating Board, Berkeley, Eng.). Nucl. Eng. Des.; 16: No. 1, 35-44(May 1971).

The stress analysis of a podded boiler-type prestressed-concrete pressure vessel subjected to pressure loading has been accomplished by means of the three-dimensional finite elements incorporated in the BERSAFE system for both a simple and more complex structural idealization. The measured strain and displacement response of the $1/10$th Hartlepool model to pressure loading have been compared to the theoretical strains and displacements predicted by a simple structural idealization and good agreement has been obtained. It is suggested that the theoretical approach of Irving and Goodall for the analysis of linear viscoelastic solids could enable the effects of creep to be determined on the stresses sustained by podded boiler-type prestressed concrete pressure vessels under long term operating conditions. (auth)

Fuels

Refer also to abstracts 49508, 49568, 49576, and 50615.

51081 (AECL–3968) USE OF ENTHALPY IMBALANCE IN EVALUATING THE DRYOUT PERFORMANCE OF FUEL BUNDLES. McPherson, G. D. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Jun 1971. 29p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

To characterize the dryout performance of a multi-element fuel bundle one must consider the value of the maximum subchannel coolant enthalpy rise rate relative to the average value; the greater the imbalance, the poorer the performance. Empirical dryout data have been analyzed for a variety of bundles and arrangements and a quantitative relationship found between the enthalpy imbalance and the dryout performance. This concept is applied to the evaluation and comparison of various bundles and examples are given of its application to parametric studies and to the calculation of absolute dryout power. (8 references) (auth)

51082 (CEA-R–4197) MEASUREMENTS UNDER IRRADIATION OF THE VARIATIONS IN LENGTH OF UO_2 FUEL RODS CLAD WITH ZIRCONIUM–COPPER. CIRCE EXPERIMENTS. Hueber, Claude; Stora, Jean-Pierre (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires); Ringot, Claude (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jul 1971. 34p. (In French). Dep. NTIS (U. S. Sales Only).

Two fuel rods composed of UO_2 pellets and Zr–Cu cladding were irradiated in CYRANO type capsules. The widths of the shoulders of the pellets which have a dished face, differ in the fuel rods. Both rods were equipped with an extensometric gauge, allowing the length changes to be continuously measured and analyzed during irradiation, particularly during the start up. After a maximum elongation, the lengths of the rods were observed to decrease slowly at steady power, due to creep of the fuel, which was appreciable above 950°C. Rapid thermal cycling is shown to cause an increase in length (thermal ratchetting). (8 references) (auth) (France)

51083 (GA–10517) GAS-COOLED FAST BREEDER REACTOR. Progress Report, February 1, 1970–January 31, 1971. (Gulf General Atomic Co., San Diego, Calif.). 26 Feb 1971. Contract AT(04-3)-167. 50p. Dep. NTIS.

The tasks of the Gas-Cooled Fast Breeder Reactor program are program planning, core engineering design and analysis, fuels and materials surveillance, irradiation tests, and nuclear analysis and reactor physics. A review of in-reactor creep data in austenitic stainless steels is given. Progress is reported on the irradiation test results and analyses of the instrumented, $(U-Pu)O_2$-fueled, pressure-equalized GCFR fuel rod being irradiated in the ORR. In the fast-flux test program, a seven-rod subassembly (F-1) was inserted in the EBR-II for start of irradiation. A review of recent developments in cross-section evaluations for ^{239}Pu, ^{240}Pu, and ^{238}U is summarized. (auth)

51084 (GA–10654) GAS-COOLED FAST BREEDER REACTOR. Quarterly Progress Report, February 1, 1971–April 30, 1971. (Gulf General Atomic, Inc., San Diego, Calif.). 28 May 1971. Contract AT(04-3)-167. 43p. Dep. NTIS.

The tasks of the Gas-Cooled Fast Breeder Reactor (GCFR) program are program planning, core engineering design and analysis, fuels and materials surveillance, irradiation tests, and nuclear analysis and reactor physics. The development program plan document for the design and construction of the GCFR demonstration plant is discussed. A review of results of world-wide fast flux irradiation tests of fuel rods is given. The current irradiation test results and analyses are reported for capsule GB-9, which is operating in ORR and has reached 35,000 MWd/Te. Plans for the irradiation of a similar but improved capsule (GB-10) are discussed and an analysis of the gaseous fission-product release fractions expected from GB-10 is presented. The status of the fast-flux experiment F1 (X094) in EBR-II is also reported. Out-of-pile measurements of interdiffusion of krypton in helium are reported. Nuclear analysis and reactor physics included a review of the LMFBR critical assembly program. (auth)

51085 (IDO-ITR–103) THE RESPONSE OF UO_2 FUEL RODS TO POWER BURSTS: 5/16-INCH OD, PELLET AND POWDER FUEL, ZIRCALOY CLAD. Miller, R. W.; Lussie, W. G. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Jan 1969. Contract AT(10-1)-205. 71p. Dep. NTIS.

Fuel rods of 0.3125-inch OD with Zircaloy-2 cladding and either pellet or powder uranium dioxide fuel form enriched to 7% were fabricated by General Electric Company by commercial techniques and supplied for the Subassembly Testing Program. These fuel rods were inserted individually in the CDC reactor in a water environment and subjected to power bursts with half-widths of approximately 12 to 30 msec (asymptotic periods between 3 and 7 msec) resulting in sudden releases of energy within the urania ranging from 190 cal/g of UO_2 to 440 cal/g of UO_2. Results indicate a failure threshold less than 250 cal/g for pellet fuel but greater than 250 cal/g for powder fuel. Conversion efficiencies of thermal (nuclear)-to-mechanical energy, pressures, and metal-water reactions for the tests are reported and indicate that powder fuel produces consistently less severe consequences than does pellet fuel. The tests indicate, for the type accident simulated, that a strain upon reactor containment would likely occur with pelleted fuel above 250 cal/g and that fuel replacement would be essential after accidents in the range of 190 cal/g. 4 references. (auth)

51086 (IN-ITR–107) BEHAVIOR OF 5-INCH LONG, $1/4$-INCH OD, ZIRCALOY-2 CLAD OXIDE FUEL RODS SUBJECTED TO HIGH-ENERGY POWER BURSTS. Martinson, Z. R. (Idaho Nuclear Corp., Idaho Falls). Aug 1969. Contract AT(10-1)-1230. 79p. Dep. NTIS.

Transient fuel performance tests have been performed on Zircaloy-2 clad SPXM-type fuel rods in the Capsule Driver Core (CDC) at Spert. The SPXM fuel rods tested contained 10.5% enriched, pelletized UO_2 clad with $1/4$-inch OD cold-worked Zircaloy-2. The rods were encapsulated in stagnant water at ambient temperature and atmospheric pressure and subjected to power bursts with half-widths of 40 msec to 12 msec (asymptotic periods varying from 8 msec to 3 msec) resulting in rapid energy releases within the test fuel rod of 170 to 655 calories per gram of UO_2. Damage to the fuel rods ranged from discoloration, bowing, and cladding growth at 170 cal/g to complete fragmentation of the fuel and cladding at 655 cal/g of UO_2. Results indicate an initial cladding failure threshold between 240 and 257 cal/g, where brittle fracture and nearly complete loss of cladding strength were observed. Failure from melting of the cladding initially occurred at 267 cal/g of UO_2. A prompt failure threshold (cladding surface temperatures less than melting) was first observed at an energy deposition of 360 cal/g of UO_2. The prompt failure threshold also marked the onset of capsule pressure generation and mechanical energy production. The measured cladding surface temperatures at the time of cladding failure decreased as a function of total energy deposition. For the 655 cal/g of UO_2 tests, the cladding surface temperature rise was only about 300°C at the time of cladding failure. Metal-water reaction of the cladding increased as a function of energy deposition; essentially all of the cladding reacted for energies greater than 600 cal/g of UO_2. Transient capsule pressures and mechanical energy generation increased rapidly for energies greater than 600 cal/g of UO_2. At 655 cal/g, the maximum measured pressure was about 1750 psig, and the nuclear to mechanical energy conversion was about 2.8%. At 490 cal/g, the maximum pressure was only about 180 psig with a nuclear to mechanical energy conversion of only 0.2%. 9 references. (auth)

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51087 (IN-ITR-109) EFFECTS OF AXIAL LENGTH ON THE RESPONSE OF ZIRCALOY CLAD, UO_2 FUEL RODS TO POWER BURSTS. Siefken, L. J. (Idaho Nuclear Corp., Idaho Falls). Dec 1969. Contract AT(10-1)-1230. 52p. Dep. NTIS.

Commercially fabricated fuel rods with active fuel lengths of 24 inches were individually subjected to power bursts in the Capsule Driver Core (CDC). The fuel rods tested contained either pellet or vipac-powder UO_2 fuel and were clad with cold-worked Zircaloy-2. They had a maximum to minimum axial fission density ratio of 2.0. The adiabatic energy deposited in the test rods at their axial flux peak by the power bursts ranged from 245 and 460 cal/g of UO_2. The threshold of failure and the consequences induced were basically similar to the results of tests on shorter (5.2-inch active length) but otherwise similar test rods. This result indicates that an axial fuel length of 5 inches is sufficient to provide representative fuel performance information in the CDC. (12 references) (auth)

51088 (IN-ITR-111) EFFECTS OF CLADDING MATERIAL AND HEAT TREATMENT ON THE RESPONSE OF WATER-LOGGED UO_2 FUEL RODS TO POWER BURSTS. Stephan, L. A. (Idaho Nuclear Corp., Idaho Falls). Jan 1970. Contract AT-(10-1)-1230. 53p. Dep. NTIS.

Waterlogged fuel rods clad with both Zircaloy-2 and stainless steel were subjected to transient tests in the Capsule Driver Core (CDC) at Spert. The tests were performed primarily for the purpose of determining the effect of cladding material and cladding heat treatment on the energy deposition required to cause cladding failure, and to obtain further information on the consequence associated with the failure of waterlogged fuel. The waterlogged fuel rods tested were $\frac{1}{4}$-inch in diameter, had an active length of 5 inches, and contained 5%-enriched pelletized UO_2. The cladding material was either Zircaloy-2 (annealed or cold worked) or 304-type stainless steel (annealed or cold worked). The rods were individually subjected to power bursts of either 5.5 or 3.0 msec (total energy depositions of either 225 or 430 cal/g of UO_2) in an ambient water environment. A total of 10 waterlogged fuel rods were tested. Results indicate a failure threshold in the range of 155 to 165 cal/g of UO_2 for annealed Zr-2 cladding, 85 to 150 cal/g of UO_2 for cold-worked Zr-2 cladding, 330 to 350 cal/g of UO_2 for annealed 304-type stainless steel cladding, and 110 to 115 cal/g of UO_2 for cold-worked 304-type stainless steel cladding. The Zircaloy clad rods were tested at both 5.5 and 3.0 msec periods. The failure threshold of the annealed Zr-2 clad rods was relatively insensitive to period, whereas the shorter period apparently caused the failure threshold of the cold-worked Zr-2 clad rods to decrease significantly. The kinetic energy of the water column, resulting from conversion of thermal to mechanical energy was considerably higher for all of the 3.0 msec tests than for the 5.5 msec tests. 11 references. (auth)

51089 (IN-ITR-112) THE RESPONSE OF UO_2 FUEL RODS TO POWER BURSTS. DETAILED TESTS ON 5/16-INCH OD, PELLET FUEL, ZIRCALOY CLAD RODS. Lussie, W. G. (Idaho Nuclear Corp., Idaho Falls). Jan 1970. Contract AT(10-1)-1230. 56p. Dep. NTIS.

The results of Test Series 107 of the Spert Subassembly Testing Program are presented. The fuel rods used in these tests contained 7%-enriched pellet UO_2 fuel clad with 0.020-inch wall, 0.3125-inch OD, Zircaloy-2 tubing and were fabricated by the General Electric Company using the same techniques that are currently used in commercial BWR fuel rod production. The fuel rods were inserted individually in the CDC reactor in an ambient water environment and subjected to power bursts (asymptotic periods between 5.58 and 4.23 msec) resulting in sudden releases of energy within the fuel ranging from 216 to 313 cal/g of UO_2. The data indicate that failure occurs by melting of the cladding and the failure threshold is in the energy deposition range between 223 and 256 cal/g of UO_2. (14 references) (auth)

51090 (IN-ITR-113) EFFECTS OF BURNUP ON FUEL FAILURE. I. POWER BURST TESTS ON LOW BURNUP UO_2 FUEL RODS. Miller, R. W. (Idaho Nuclear Corp., Idaho Falls). Jul 1970. Contract AT(10-1)-1230. 146p. Dep. NTIS.

The tests with irradiated fuel in the Subassembly Testing Program are described. The Zircaloy-2 clad fuel rods used consisted of two types, the GEX-type with $\frac{5}{16}$-inch OD and the GEP-type with $\frac{9}{16}$-inch OD, representing standard BWR fuel. Both rods were preirradiated; the GEX up to 4500 MWd/MTU, and GEP rods up to 1100 MWd/MTU, and then tested in the Capsule Driver Core under power burst conditions. Results indicate clearly that burnup can severely affect the capability of fuel rods to withstand overpower accidents by changing the mode of failure from passive meltdown to cladding rupture with attendant higher pressure pulses, and reducing the energy necessary to cause failure to as low as 147 cal/g-UO_2. Since the effects found result from very low burnup, the tests imply that a serious safety problem may exist at LWR discharge burnups which are typically in the 30,000 to 50,000 MWd/MTU range. (18 references) (auth)

51091 (IN-ITR-114) RESPONSE OF MIXED OXIDE FUEL RODS TO POWER BURSTS. Lussie, W. G. (Idaho Nuclear Corp., Idaho Falls). Apr 1970. Contract AT(10-1)-1230. 82p. Dep. NTIS.

The results of Test Series 301 of the Spert Subassembly Test Program are presented. The fuel rods used in these tests contained plutonium recycle fuel, a mixture of plutonium and uranium oxides, in the form of either solid or hollow pellets. The fuel rods were clad with 0.020-in. wall, $\frac{5}{16}$-inch OD, Zircaloy-2 tubing and were fabricated by the General Electric Company using techniques representative of current recycle fuels technology. Each fuel rod was inserted individually in the CDC reactor in an ambient water environment and subjected to a power burst which resulted in a sudden release of energy within the fuel. The data indicate that for the solid pellet, mixed oxide fuel rods, failure occurred by melting of the cladding and the failure threshold was in the energy deposition range between 225 and 274 cal/g of fuel. For the hollow pellet, mixed oxide fuel rods, failure occurred by splitting of the cladding and the failure threshold was in the energy deposition range between 223 and 275 cal/g of fuel. Also, for the hollow pellet fuel rods the consequences of failure were less severe than those of a solid pellet UO_2 fuel rod of similar design. (17 references) (auth)

51092 (IN-ITR-116) RESPONSE OF FUEL ROD CLUSTERS TO POWER BURSTS. Siefken, L. J. (Idaho Nuclear Corp., Idaho Falls). May 1970. Contract AT(10-1)-1230. 95p. Dep. NTIS.

Seven clusters of fuel rods were subjected to power bursts in the Capsule Driver Core (CDC). Each cluster consisted of five Zircaloy-2 clad fuel rods containing pelletized UO_2. The spacing of the fuel rods within each cluster was representative of the fuel rod spacing in a typical power reactor core. Thermo-hydraulic constraints were imposed upon some of the test clusters to control heat transfer conditions. These constraints varied from partial isolation of the test clusters from the relatively large reservoir of cool water in the capsule to virtually complete isolation of the test clusters from this reservoir. The test clusters were irradiated in the CDC to effect cluster average fuel enthalpies ranging from 147 cal/g of UO_2 to 370 cal/g of UO_2. The primary results of the series of experiments were: the failure threshold of cluster fuel rods in an open lattice arrangement (no constraints) was the same as for single rods; the failure threshold for SPXM rods was reduced from about 240 cal/g of UO_2 to less than 225 cal/g of UO_2 when thermohydraulic constraints in the form of metal canisters enclosed the fuel rods; the failure consequences (pressure and nuclear-to-mechanical energy conversion) were higher for a cluster subjected to an average energy deposition of 370 cal/g of UO_2 than for a comparable test on a single rod; and cladding surface temperatures were about the same for clusters and single rods. (16 references) (auth)

51093 (IN-ITR-117) RESPONSE OF HETEROGENEOUS MIXED-OXIDE FUEL RODS TO POWER BURSTS. Lussie, W. G. (Idaho Nuclear Corp., Idaho Falls). Sep 1970. Contract AT-(10-1)-1230. 57p. Dep. NTIS.

The results of Test Series CDC-302 of the Spert Subassembly Test Program are presented. This test series investigated the behavior of heterogeneous PuO_2 distributions in thermal recycle fuels during power bursts. In the fuel rods used for these tests, controlled heterogeneity was introduced by embedding 500 μ—diameter PuO_2 microspheres in 7.2%-enriched UO_2 fuel pellets. Only one microsphere was contained in a pellet and, to reduce any possible axial effects, the pellets containing microspheres were spaced alternately between 7.2%-enriched UO_2 pellets having no microspheres. The fuel rods had an active length of about 5 in. and were clad with 20-mil wall, $\frac{5}{16}$-in. OD Zircaloy-2 tubing. Each fuel rod was inserted individually into the test space of the CDC reactor and subjected to a power burst which resulted in a sudden release of energy within the fuel. The data from these tests indicate that failure in the heterogeneous mixed oxide fuel rods resulted from melting of the cladding at localized hot spots produced by the PuO_2 microspheres and that the failure threshold was in the energy deposition range between 200 and 213 cal/g of fuel. This compares with a failure threshold in the range of about 225 to 250 cal/g of fuel as previously determined for rods having a similar design but containing either pellet UO_2 or a homogeneous UO_2–PuO_2 mixture as fuel. (19 references) (auth)

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51094 (IN-ITR-202) DESCRIPTION OF FACILITY AND DATA ACQUISITION AND PROCESSING SYSTEM FOR THE HEATED CORE PORTION OF THE 800 TEST SERIES OF THE SEMISCALE BLOWDOWN AND EMERGENCY CORE COOLING (ECC) PROJECT. Olson, D. J.; Van Haverbeke, J. G. (Idaho Nuclear Corp., Idaho Falls). Jul 1970. Contract AT(10-1)-1230. 24p. Dep. NTIS.

The facility and the data acquisition and processing system used for the 800 Series heated core tests of the Semiscale Blowdown and Emergency Core Cooling (ECC) Project are described. Details regarding the semiscale system are presented to permit modeling and analysis by those engaged in the use of semiscale test results for code development and evaluation. The size and configuration of the components, materials of construction, and distribution of liquid volumes in the simulated pressurized water reactor system are given. The location and type of data acquisition devices and the method of processing data are also described. (auth)

51095 (JAERI-12704) DESIGN FOR POWER REACTOR FUEL ASSEMBLY. Design Data of Temperature, Heat Flux Distribution, and Mechanical Strength. Morishima, Atsuyoshi; Harayama, Yasuo; (and others) (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment). Jun 1969. 169p. NTIS (U. S. Sales Only).

The data are presented which are necessary for reactor fuel design. They include mechanical, thermal and hydraulic properties, thermal stresses, fission product release rates and $\int k d\theta$ of fuel materials for boiling-water type reactors. The materials concerned are helium, water steam, UO_2, stainless steels, Inconel-X 750, and zirconium alloys. (auth) (Japan)

51096 (JAERI-13661) COMPARATIVE STUDY IN THE USE OF CARBIDE FUEL AND OXIDE FUEL IN 1000 MW(e) SODIUM COOLED FBR. Ikushima, Tsuyoshi (Japan Atomic Energy Research Inst., Tokai). Jun 1969. 28p. NTIS (U. S. Sales Only).

The nuclear characteristics of carbide and oxide fuels in 1000 MW(e) FBR are given. Use of carbide fuel shows several advantages over oxide fuel. (1) The higher breeding ratio is obtained. (2) The sodium void reactivity effect can be negative. (3) The Doppler coefficient is nearly the same. (auth) (Japan)

51097 (JUL-752-RG) DIFFUSION OF METALLIC FISSION PRODUCTS AND HEAVY METALS IN THE LAYERING OF FUEL PARTICLES FOR HIGH-TEMPERATURE REACTORS. Engelhard, Juergen (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Apr 1971. 121p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Technische Hochschule, Aachen, Ger.

Both experimental and theoretical studies were performed about the transport of heavy metals and solid fission products into the coating of various types of fuel particles. The particles were irradiated at low temperature and, then, heated to a range between 1,000 and 1,600°C to simulate conditions in a high temperature reactor. Experimental studies yielded the radial distribution in the coating of fuel particles for ^{235}U, ^{232}Th, ^{233}Pa, ^{95}Zr, ^{95}Nb, ^{141}Ce, ^{103}Ru, ^{140}Ra, ^{137}Cs, and ^{131}I. A mathematical model was developed to compute coefficients for transport and evaporation. Experimental and theoretical studies showed that, up to 1300°C, no significant contamination of the cooling gas occurs in a high temperature reactor. Release of fission products could be caused by contamination of the coating with uranium as well as by defects in the coating. As far as ^{131}I was concerned, the studies showed that this fission product essentially behaved up to 1500°C like a noble gas. (43 references) (H.B.G.)

51098 (WAPD-TM-973) IN-PILE DIMENSIONAL CHANGES OF ZIRCALOY-4 TUBING HAVING LOW HOOP STRESSES (LWBR DEVELOPMENT PROGRAM). Daniel, R. C. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jul 1971. Contract AT(11-1)-Gen-14. 60p. Dep. NTIS.

Diameter and length changes were measured for 0.25 to 0.30 inch O.D. fuel rods having Zircaloy-4 cladding thicknesses from 17 to 22 mils. The external coolant pressure (2000 psi) yielded hoop stresses in the range of 11,000 to 15,000 psi. Short rods (6 to 11 inch) were irradiated in an ETR loop (peak fast flux $\cong 1.5 \times 10^{14}$ nv) while long rods (~10 feet) were irradiated in a NRX loop (2.5×10^{13} nv). A method is described for separating components of the diameter and length changes caused by Zircaloy growth, external pressure, and fuel-clad interactions. It is concluded that the diameter shrinkages of the former rods (up to about 1 mil, 0.4%) were caused entirely by the external pressure. However, those of the latter rods (up to ~2 mils, 0.8%) were strongly dependent on fuel-clad interactions, with large diameter shrinkages being accompanied by large length increases (up to about 0.7%). A calculational method based on the CYGRO computer program is proposed for simulating such behavior for long rods. 8 references. (auth)

51099 (WHAN-SA-86) EXPERIMENTAL TEMPERATURE DISTRIBUTIONS IN LIQUID METAL FAST BREEDER REACTOR FUEL ASSEMBLIES: THE EFFECT OF BOWING DISTORTION. Collingham, R. E.; Yatabe, J. M.; Hill, V. R.; Thorne, W. L. (Hanford Engineering Development Lab., Richland, Wash.). [1971]. Contract AT(45-1)-2170. 21p. Dep. NTIS.

In the evaluation of the design and performance of liquid metal cooled fast breeder reactor fuel assemblies, the effect of structural distortions on maximum temperature and temperature gradient is required. This effect establishes design variables such as the support points for structural spacers and fuel performance predictions such as the potential for fuel pin failure occurring through overstress caused by bowing. The analytical methods for predicting the maximum temperature and temperature profiles in these fuel assemblies have not been completely verified. The major uncertainties are associated with the distortions or diversion of the flow fields caused by structural spacers and other hardware. To support the accuracy required for an actual fuel design, electrically heated and instrumented models of Fast Test Reactor fuel assemblies were developed and tested in flowing sodium. These models duplicate the wire wrapped fuel assembly geometry except for the number of pins. The coolant and clad temperature distributions are presented for the following two structural distortions: pin bowing and bundle bowing. Pin bowing is the bowing of one pin to contact with an adjacent pin. Such bowing could be caused by failure of a spacer or thermal and mechanical stresses or both. Bundle bowing herein means the bowing of the entire bundle towards the duct wall as permitted by the tolerances between the tight bundle and duct inner diameter. These results would also be applicable to the inverse case which is perhaps more likely: bowing of the duct. (auth)

51100 PRESSURE EQUALIZATION SYSTEM FOR GAS-COOLED FAST BREEDER REACTOR FUEL ELEMENTS. Campana, Robert J. (Gulf General Atomic Co., San Diego, Calif.). Nucl. Technol.; 12: No. 2, 185-93(Oct 1971).

A system was designed for the Gas-Cooled Fast Breeder Reactor (GCFR) which equalizes the pressure within the fuel rods with the coolant pressure (85 atm of He) in order to eliminate the possibility of creep-collapse of the fuel rods. Additional advantages that result from this design are: a shortened core, relaxation of cladding tolerances, low coolant circuit activity, capability of identifying and monitoring leaking fuel elements, safer fuel handling and transport, and potential performance improvements. The system employs in-core charcoal fission-product traps and permits reactor operation with leaking fuel elements. A capsule test of the concept in the ORR was made and results indicate that pressure-equalized fuel appears to be practical and will reduce the development required for the GCFR. (auth)

51101 ANALYTIC MODEL FOR THE PREDICTION OF IN-PILE BEHAVIOR OF OXIDE FUEL RODS. Duncombe, E.; Friedrich, C. M.; Guilinger, W. H. (Bettis Atomic Power Lab., West Mifflin, Pa.). Nucl. Technol.; 12: No. 2, 194-208(Oct 1971).

The prediction and analysis of fuel rod performance in the CYGRO-3 model is an extended version of the earlier models CYGRO-1 and CYGRO-2 arising from the LWBR development program. The model assumes that circumferential and axial variations in conditions are small compared with radial variations. Fuel and clad are considered as a set of interacting concentric ring elements. Time-dependent values of temperatures, stresses and deformations (elastic and creep effects) are calculated as the response to a history of coolant water conditions and of rod power and neutron flux. Provision is made to calculate effects of swelling due to pore growth and of thermally induced pore migration in the fuel. An approximation to fuel property changes as a result of cracking is introduced via changes in the elastic relationships. Frictional interaction between fuel and clad when the latter is in the collapsed condition is provided. Forces introduced by fuel rod supports are included. A first order calculation of straightening moments introduced by circumferential variation in power can also be carried out. (14 references) (auth)

51102 DEFORMATION OF FUEL ELEMENT BOXES IN GAS-COOLED FAST BREEDER REACTORS DUE TO NEUTRON IRRADIATION INDUCED SWELLING OF STEEL. Helbling, W.; von Allmen, I.; Haeberli, R. (Swiss Federal Inst. for Reactor Research, Wuerenlingen). Nucl. Eng. Des.; 16: No. 1, 59-66 (May 1971).

Calculations of the deformation of fuel element boxes in gas-

cooled fast reactors due to thermal expansion and neutron-induced swelling of steel indicate that it will not be possible to attain the target irradiation dose, unless means to prevent excessive deformations are provided. One of the proposed means consists of rotating the boxes repeatedly. Another possibility is keeping the box wall temperature below the range where swelling becomes significant. This can be accomplished by installing a thermal barrier on the inner box surface and cooling with a gas stream in the gap between the boxes. (auth)

51103 INTO THE FUTURE WITH NUCLEAR FUEL. Davis, Michael. Fuel; 50: No. 2, 157-74(Apr 1971).

The role of nuclear fuel in supplying future energy needs is examined, and supply and demand problems for uranium and thorium are considered. The influence of fast breeder reactors on nuclear fuel supply is discussed. (H.D.R.)

51104 TRANSIENT THERMOELASTIC STRESSES IN HOMOGENEOUS SPHERICAL FUEL ELEMENTS. Beers, D. E. (Fiber Industries Inc., Charlotte, N. C.); Kettleborough, C. F. Nucl. Eng. Des.; 16: No. 1, 67-86(May 1971).

Two methods are described to obtain the solution of the transient thermoelastic stress distribution in a homogeneous spherical fuel element. The first is the classical approach involving the simultaneous solution of the displacement potential equation $(\nabla^2\chi = (1 + \mu/1 - \mu)\alpha\Delta T)$ for the particular integral and the biharmonic stress function equation $(\nabla^4\psi = 0)$ for the complementary solution. In this method the solution for the particular integral produces a stress distribution which does not satisfy the real boundary conditions. However a correction is obtained using the complementary solution so that the sum of the two solutions satisfy the boundary conditions. It is shown that the classical solution leads to great computational difficulties even for the case where the temperature is a function only of the radius. As an alternative method it is shown that the complete solution satisfies the displacement equation $\nabla^2\chi = (1 + \mu/1 - \mu)\alpha\Delta T + B$ (where B is a constant). The problem simplifies to the solution of Poisson's equation. This second solution, which has been called the direct displacement method, is much easier to program and takes up much less computer storage. In order to check the program accuracy and limitations, the temperature distribution is initially assumed to be a function of radius only; closed-form solutions are available for this case for steady-state conditions. Further results are obtained for the transient case of a heated sphere where the temperature is a function of R and θ, axial symmetry being assumed about a vertical axis. Typical results indicate that maximum stresses occur when steady-state temperatures are reached and occur near the center of the sphere rather than at the surface. A third technique which has been investigated is the finite-element method assuming a linear displacement variation. However, the effort involved is much greater than that associated with the solution of Poisson's equation for the regular system used. Work is progressing on a transient 3-dimensional solution. (auth)

51105 PROBABILITY OF ROD- AND PELLET FAILURE IN FAST REACTORS (HLB). Schoeneberg, R.; Ernst, H. (Allgemeine Elektrizitaets-Gesellschaft, Frankfurt am Main). Nucl. Eng. Des.; 16: No. 1, 87-99(May 1971). (In German).

The operating temperature within the fuel rods of a nuclear reactor or the linear rod power must not exceed certain limiting values. Still higher power densities, for example, may lead to fuel melting or may increase the creep and carbonization rate of the cladding. Probability analysis methods are used to assess the amount of pellet- and pin failures taking into account the actual power distribution and the burnup behavior of the core. In view of the lack of experimental information about the density functions of pellet power and pellet- or rod-failure plausible assumptions — mainly about the latter one — had to be made. Quantitative failure rates have been calculated with the aid of three small computer programs. The equations used in these programs are derived and the calculational results are tabulated and discussed in the case of the sodium-cooled carbide-fuelled fast breeder. (auth)

Auxiliary and Emergency Systems

Refer also to abstract 49591.

51106 (ANL/EBR-38) OPERATING EXPERIENCE AND EVALUATION OF THE EBR-II EMERGENCY POWER SYSTEM. Goodrich, J. R. (Argonne National Lab., Idaho Falls, Idaho). Apr 1971. Contract W-31-109-eng-38. 16p. Dep. NTIS.

The history, growth, and operating experience associated with the emergency power system for Experimental Breeder Reactor II (EBR-II) are presented. The EBR-II emergency power system includes the reactor plant, power plant, sodium boiler plant, fuels and examination facility, laboratory and office building, and miscellaneous yard facilities. The general arrangement of the system, the present load, and the anticipated load growth are described. Evaluation of the EBR-II emergency power system indicates that portions of the system subject to anticipated load growth are loaded to capacity. Modifications to provide overload relief and to improve system reliability are proposed. (auth)

51107 (IN-1394) CONTAINMENT BEHAVIOR OF XENON AND IODINE UNDER SIMULATED LOSS-OF-COOLANT ACCIDENT CONDITIONS IN THE CONTAMINATION-DECONTAMINATION EXPERIMENT. Nebeker, R. L.; Lakey, L. T.; Palica, W. P., Keller, J. H.; Black, D. E.; Schindler, R. E. (Idaho Nuclear Corp., Idaho Falls). Jun 1971. Contract AT(10-1)-1230. 178p. Dep. NTIS.

Eleven runs were conducted at low radioactivity levels (initial iodine-131 and xenon-133 concentrations ranging from 1 to 260 μCi/l) in the Contamination-Decontamination Experiment (CDE), a pilot-plant facility for producing and sampling fission product aerosols. In these runs, a single radionuclide (iodine-131 or xenon-133) was injected into a steam-air atmosphere in the 2.4-m^3 CDE containment vessel. The containment atmosphere, undisturbed by the operation of emergency core cooling, pressure reduction, or filter safety systems, was sampled during pressure and temperature transients representative of those expected for a reactor loss-of-coolant accident. The information obtained from these runs on the undisturbed containment behavior of xenon, elemental iodine, organic iodides, and hypoiodous acid is summarized and compared with data available from other facilities. Potential applications of the data and additional work needed are discussed. The CDE systems, test procedures, detailed run results, and samplers also are described. 46 references. (auth)

51108 (ORNL-4623) REMOVAL OF ELEMENTAL IODINE FROM REACTOR CONTAINMENT ATMOSPHERES BY SPRAYING. Parsly, L. F. (Oak Ridge National Lab., Tenn.). Sep 1971. Contract W-7405-eng-26. 64p. Dep. NTIS.

An analytical model that describes the removal of elemental iodine from containment atmospheres by sprays is presented. Elemental iodine is usually the predominant form released. Experimental results from experiments reported by others, as well as results from 28 iodine-removal experiments, are presented and discussed. The results show that present models for iodine removal by sprays are adequate and that sprays are an effective way to remove iodine. (40 references) (auth)

51109 IEEE STANDARD FOR ELECTRICAL PENETRATION ASSEMBLIES IN CONTAINMENT STRUCTURES FOR NUCLEAR FUELED POWER GENERATING STATIONS. IEEE No. 317 1971. New York: Institute of Electrical and Electronics Engineers, Inc. (1971). 11p. Available from Institute of Electrical and Electronics Engineers, New York.

The mechanical, electrical, and test requirements for the design, construction, and installation of electrical penetration assemblies in containment structures for stationary nuclear fueled power generating stations are described. The electrical conductor and insulation characteristics of external circuits which connect to penetration assemblies are beyond the scope of these criteria. (auth)

51110 FLAME RECOMBINATION OF OXYGEN AND HYDROGEN. Siegler, M.; Moore, G. E. (General Electric Co., San Jose, Calif. General Electric Co., Schenectady, N. Y.). Chem. Eng. Progr., Symp. Ser.; 66: No. 104, 1-11(1970).

The design objectives and combustion principles are discussed for disposal by flame recombination of the radiolytic off-gas from a water-cooled nuclear reactor. The off-gas is mainly a stoichiometric hydrogen-oxygen mixture. It is shown that the characteristics of the water-cooled porous plug burner are not only consistent with but appear necessary to meet both the basic and practical requirements of the problem. The development of the components for a safe, reliable and relatively inexpensive recombiner is described. A versatile facility was built for testing of complete burner systems as well as related safety systems. (auth)

51111 HYDROGEN MONITOR FOR DETECTION OF LEAKS IN LMFBR STEAM GENERATORS. Vissers, D. R.; Holmes, J. T.; Nelson, P. A.; Bartholme, L. G. (Argonne National Lab., Ill.). Nucl. Technol.; 12: No. 2, 218-25(Oct 1971).

A monitoring system was developed for detecting leaks in LMFBR steam generators by the detection of the hydrogen produced in the sodium-water reaction. The principal capabilities of this detection system are rapid response, high sensitivity, and high stability and reliability. The monitoring system is based on the detection of a change in hydrogen concentration

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in sodium by measurement of the change in the rate of hydrogen diffusion through a nickel membrane immersed in the sodium. A vacuum is drawn on the membrane by an ion pump, and the partial pressure of hydrogen on the vacuum side, a measure of the hydrogen flux and the hydrogen activity in the sodium, is determined by the measurement of the current to the ion pump. The response time of the monitor depends chiefly on the hydrogen-diffusion properties of the nickel membrane. Transient-diffusion calculations indicate that 10 sec after a sudden change in the hydrogen concentration in the sodium, the change in the hydrogen flux from the membrane would be 70% of the eventual total change in flux for a 10-mil-thick nickel membrane at 500°C. With a stable high-voltage power supply, the noise on the recorded ion pump signal was less than 0.2% of the signal output for a hydrogen concentration in sodium of 0.1 to 0.2 ppm. This level of sensitivity and stability are adequate to detect a water leak from the steam generator into the LMFBR secondary sodium of 10^{-4} lb/sec at a sodium flow of 10^{7} lb/hr in less than 1 minute, if the hydrogen concentration in the secondary sodium is approximately 0.1 ppm. (12 references) (auth)

51112 MODIFICATION OF THE EBR-II CORE FUEL HANDLING HOLDDOWN MECHANISM. Waldo, J. B.; Sine, H. W.; Remsburg, J. S. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 29(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51113 IEEE CRITERIA FOR CLASS IE ELECTRIC SYSTEMS FOR NUCLEAR POWER GENERATING STATIONS. IEEE No. 308 1970. New York; Institute of Electrical and Electronics Engineers, Inc. (1970). 8p. Available from Institute of Electrical and Electronics Engineers, New York.

Those parts of the electric systems in stationary land-based nuclear power generating stations that provide electric power to the Class IE electric equipment are described. The electric systems included are comprised of the following interrelated systems: alternating-current power systems, direct-current power systems, and vital instrumentation and control power systems. These systems consist of power supplies (e.g., connections to the station switchyard, generating units, batteries), distribution equipment and components (e.g., transformers, switchgear, bus, cable, battery chargers, inverters), and instrumentation and controls (e.g., relays, meters, switches, control devices). This standard does not apply to the station generator, generator buses, step-up and auxiliary transformers, switchyard, the transmission lines, and the transmission network. (auth)

51114 IEEE TRIAL-USE STANDARD: GENERAL GUIDE FOR QUALIFYING CLASS I ELECTRIC EQUIPMENT FOR NUCLEAR POWER GENERATING STATIONS. IEEE No. 323 1971. New York; Institute of Electrical and Electronics Engineers, Inc. (1971). 7p. Available from Institute of Electrical and Electronics Engineers, New York.

The basic requirements for the qualification of Class I electric equipment are described. This is equipment which is essential to the safe shutdown and isolation of the reactor or whose failure or damage could result in significant release of radioactive material. (auth)

51115 VESSELS FOR SODIUM-COOLED FAST NUCLEAR REACTORS: GENERAL CONSIDERATIONS AND CRITICAL EXAMINATION OF SOME VESSEL STRUCTURES. Curioni, Sergio (Comitato Nazionale per l'Energia Nucleare, Bologna). Nucl. Eng. Des.; 16: No. 1, 1-12(May 1971).

Some general characteristics of vessels for sodium-cooled fast nuclear reactors are discussed, emphasizing their differences from the vessels of thermal nuclear reactors. A critical bibliographic investigation of some vessels already constructed or under design is carried out. (auth)

51116 ASEISMIC DESIGN OF THE ATR CHARGE MACHINE. Toyoshi, Takanori (Fuji Electric Co. Ltd., Kawasaki, Japan). Fuji Jiho; 43: No. 11, 1046-52(Nov 1970). (In Japanese).

A certain number of structures and mechanisms were devised for aseismic design of the charge machine for ATR. The results of their vibration analysis are described. A variety of devices were adopted to withstand earthquake especially on the following points; proportion of the whole machine, slack of the machine, structure to increase rigidity, and structure to allow relative displacement between the machine and pressure tube. The charge machine was assumed to be a three-dimensional beam structure, analysis of natural frequency was carried out by finite element method, and earthquake response was determined by model analysis. As a result, it has been confirmed that the ATR charge machine has enough rigidity to withstand earthquake. In the next stage of a series of dynamic analyses, experiments were performed with a $1/10$ model and it has been confirmed that the experimental values agree well with the calculation by this computer code. (Japan)

51117 PROPOSED IEEE CRITERIA FOR NUCLEAR POWER PLANT PROTECTION SYSTEMS. IEEE No. 279 1968. New York; Institute of Electrical and Electronics Engineers, Inc. (1968). 5p. Available from Institute of Electrical and Electronics Engineers, New York.

Minimum requirements for the safety-related functional performance and reliability of protection systems for stationary, land-based nuclear reactors producing steam for electric power generation is described. Fulfillment of these requirements does not necessarily fully establish the adequacy of protective system functional performance and reliability. On the other hand, omission of any of these requirements will, in most instances, be an indication of system inadequacy. The nuclear power plant protection system encompasses all electric and mechanical devices and circuitry (from sensors to actuation device input terminals) involved in generating those signals associated with the protective function. These signals include those that actuate reactor trip and that, in the event of a serious reactor accident, actuate engineered safeguards such as containment isolation, core spray, safety injection, pressure reduction, and air cleaning. (auth)

51118 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Nichols, Ronald William; Beresford-Hartwell, Geoffrey Michael (to Atomic Power Constructions Ltd.). British Patent 1,243,372. 18 Aug 1971. Filed 30 Aug 1968.

Reference is made to reactors of the type that incorporate auxiliary heat exchangers for removing heat from primary coolant during unusual operating conditions, and generating steam therefrom. In the system described provision is made for steam from the auxiliary exchangers to be fed to a de-aerator that feeds a pump supplying feedwater to the main heat exchangers. Operation of the de-aerator is ensured in all circumstances in which the pump is operating and a large static head is not required, so that the cost of a structure to support the heavy de-aerator at the required height to give such a static head is avoided; the de-aerator can be mounted at a convenient position not determined by the transient static head requirements, but merely by the steady state requirements of the pump. A reactor embodying this system is described in detail. (UK)

Operation and Economics

51119 (WASH-1180) CONCEPT: A COMPUTER CODE FOR CONCEPTUAL COST ESTIMATES OF STEAM-ELECTRIC POWER PLANTS. STATUS REPORT. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Apr 1971. Contract W-7405-eng-26. 43p. GPO $0.50.

A computer code, CONCEPT, was developed to provide conceptual capital cost estimates for single-unit nuclear and fossil-fueled power plants. Cost estimates can be made with this code as a function of plant type and size, location, and date of operation. Output from the code includes a detailed breakdown of the estimate into direct and indirect costs according to the USAEC accounting system described in document NUS-531. The cost model currently provided by the code is only for PWR plants, but work is in progress to provide cost models for other types of power plant, including BWR, LMFBR, coal-fired and oil-fired plants. (8 references) (auth)

51120 CONFERENCE ON REACTOR OPERATING EXPERIENCE, DENVER, COLORADO, AUGUST 8-11, 1971. Farmakes, Ruth (ed.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 1-59(1971). (CONF-710808).

Included are 74 summaries of papers on the technical and administrative aspects of research, test, and power reactor operation. Each paper is cited separately by title. (H.D.R.)

For abstracts of individual papers see: 50893-50901, 50937-50951, 51015-51019, 51025, 51055-51057, 51076, 51077, 51112, 51121-51125, 51142-51149, 51177-51192, 51216, 51220-51225, 51248, and 51249.

51121 MONETARY GAINS FROM ADVANCEMENTS IN PERSONNEL RADIATION MONITORING. Owen, Frank E. (Douglas United Nuclear, Inc., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 46-7(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

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51122 BUDGETING, MEASUREMENT, AND ANALYSIS PROGRAM FOR EMPLOYEE RADIATION EXPOSURE CONTROL. Crass, L. L. (Douglas United Nuclear, Inc., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 47(1971).
From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51123 TRAINING VS EXPOSURE. Duvall, F. C.; Schmidt, W. J. (NUS Corp., Rockville, Md.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 47-8(1971).
From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51124 OPERATOR RETRAINING PROGRAM. French, J. L. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 51(1971).
From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51125 ORGANIZATION OF TWO-YEAR RETRAINING PROGRAM FOR LICENSED PERSONNEL AT OPERATING NUCLEAR POWER PLANTS. Gridley, R. L. (General Electric Co., San Jose, Calif.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 52(1971).
From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51126 TECHNICAL REVIEW OF AND COST DATA FOR REACTOR CONCEPTS. Combustion; 42: No. 12, 12-23(Jun 1971).

Development, operating, and fuel cycle costs for water-cooled power reactors, HTGR-type power reactors, LMFBR-type power reactors, gas-cooled fast reactors, molten-salt breeder reactors, and Canadian heavy water reactors are analyzed and compared. (D.C.C.)

51127 U.S. EXPERIENCE WITH FAST POWER REACTORS: FERMI I. Branyan, Charles E.; Olson, William R. Combustion; 42: No. 12, 24-32(Jun 1971).

The resumption of nuclear operation by the Fermi Fast Breeder Reactor and the successful demonstration of the full licensed power capability of 200 MW(t) (65 MW(e)) has shown that a large LMFBR system can be successfully restored to operation following a major incident. Furthermore, it has shown that a major repair program involving remote maintenance under high temperature radioactive conditions in a sodium-inert gas atmosphere can be successfully accomplished. Nuclear and plant performance characteristics have generally confirmed the original design criteria, and the incorporation of a number of plant improvements and modifications has greatly improved the operating efficiency and systems performance. Even though the total nuclear operation has been limited to the equivalent of approximately 20 days at full power, over 40,000 hours of operation have been accumulated on each component of the primary and secondary sodium systems. Fuel handling transfers now exceed 2800 with over 300 transfers accomplished in 1970 alone in reloading the core for the resumption of nuclear operation. The continued operation of the Fermi reactor at 200 MW(t) with the present core and the timely incorporation of a prototype oxide core with operation at substantially higher power will continue to provide the electrical power industry with the large LMFBR plant experience essential for the demonstration of the safety and reliability of this concept for public acceptance. Technical contributions to supplement other national LMFBR programs include the potential for high-power operation to develop prototypical core flux. 8 references. (auth)

51128 U.S. EXPERIENCE WITH FAST POWER REACTORS: EBR-II. Koch, L. J. (Argonne National Lab., Ill.). Combustion; 42: No. 12, 37-42(Jun 1971).

Experience with the design, construction and operation of EBR-II has demonstrated the feasibility of the Pool-type design of LMFBR's. It has verified the advantages attributed to this concept and has provided a technical basis for extending the concept to larger reactors. This is being done by the U. K., France and the U.S.S.R. Experience to date in those countries has apparently been favorable, and will extend the EBR-II experience to larger size Pool-type systems. 4 references. (auth)

51129 MOLTEN SALT REACTORS. Grenon, Michel; Geist, Jean-Jacques. Energ. Nucl. (Paris); 13: No. 2, 86-93(Mar-Apr 1971). (In French).

Parallel to the achievement of fast reactors, the need of a development and application program for thermal breeding is evident. In the $^{233}U-^{232}Th$ fuel cycle the fluid fuel reactor systems are capable of interesting power doubling times owing to their very low specific fissile investments. Moreover the simplification of the in-situ and continuous reprocessing of fluid fuels and the improvement in the thermodynamic efficiencies of their systems, operating at higher temperatures, allow specific thermo-chemical and electric power costs lower than those of any existing plant to be envisaged. (auth) (France)

51130 WASTE HEAT USES CUT THERMAL POLLUTION. Beal, S. E. Jr. (Oak Ridge National Lab., Tenn.). Mech. Eng.; 93: No. 7, 15-19(Jul 1971).

Beneficial uses of thermal effluents from steam and nuclear power plants are analyzed. Applications such as space cooling and heating, manufacturing, transportation, and agriculture are discussed. 4 references. (D.C.C.)

51131 APPLICATION OF VARIATIONAL CALCULUS TO IN-CORE REACTOR FUEL MANAGEMENT. Miller, James Winters. Madison, Wis.; Univ. of Wisconsin (1971). 82p. University Microfilms Order No. 71-9184.
Thesis.

The in-core fuel management problem was studied by use of the calculus of variations. Two functions of interest to a public utility, the profit function and the cost function, were subjected to the constraints of criticality, the reactor burnup equations and an inequality constraint on the maximum allowable power density. It is shown that the Lagrange multipliers which arise when a constrained functional is studied are importance functions deriving their interpretation from the adjoint source term which results when the direct functions are varied. The variational solution of the initial profit rate demonstrated that there are two distinct regions of the reactor, a constant power region and a minimum inventory or flat thermal flux region. The transition point between these regions is dependent on the relative importance of the profit for generating power and the interest charges for the fuel. The fuel cycle cost function was used to optimize a three equal volume region reactor with a constant fuel enrichment in each region. The inequality constraint on the maximum allowable power density requires that the inequality becomes an equality constraint at some point in the reactor and at all times throughout the core cycle. The finite difference equations for reactor criticality and fuel burnup in conjunction with the equality constraint on power density were solved, and the method of gradients was used to locate the optimum enrichments. The results of this calculation showed that standard nonlinear optimization techniques can be used to optimize a reactor when the inequality constraints are properly applied. (Diss. Abstr. Int., B)

Safety and Siting

Refer also to abstract 49126.

51132 (BAW-1362) 1000-MWe LMFBR ACCIDENT ANALYSIS AND SAFETY SYSTEM DESIGN STUDY. Topical Report: Local Core Faults. Moore, R. W.; Bailey, D. A.; Brown, S. K.; Khan, E. U. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Jan 1971. Contract 31-109-38-2339. 201p. Dep. NTIS.
For Argonne National Lab., Ill.

The effects of local faults within the core envelope are studied. The study includes the faults that are initiated by fuel pin or spacer failures or by deposition of foreign (excore) material within a fuel pin bundle. The study does not include the complete or partial inlet blockage of a fuel assembly. The investigations of the effects of local faults cover fuel pin failure, the phenomena involved in the molten fuel-sodium interaction, and the effects of such an interaction on the core structures. (16 references) (auth)

51133 (BC-TOP-5) PRESTRESSED CONCRETE NUCLEAR REACTOR CONTAINMENT STRUCTURES. Bekowich, R. S.; Robl, F. J.; Marsh, R. O. (Bechtel Corp., San Francisco, Calif.). Aug 1971. 171p.

The basic design and construction aspects of prestressed concrete containment structures are discussed. The structures are designed to prevent fission product release to the atmosphere during postulated accidents in the pressurized water reactors and associated systems they contain. They also provide biological shielding for the reactor systems. The basic engineering approach is described and parametric evaluations required when contemplating structural modifications are discussed. Design examples are included for the structures and for their modification. (44 references) (H.D.R.)

51134 (DUN-7697) FAULT TREE SIMULATION COMPUTER PROGRAM. Crosetti, Paul A. (Douglas United Nuclear, Inc., Richland, Wash.). Jun 1971. Contract AT(45-1)-1857. 28p. Dep. NTIS.
Fault tree analysis provides a deductive functional develop-

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ment of a specific final undesired event through logic statements of the conditions which could cause the event. The usefulness of fault tree analysis is greatly enhanced through quantitative analysis or probability evaluation of the fault trees to provide a more objective basis for evaluating and improving the systems and to improve the precision of performance measurements and trade-off studies. Since a primary use for the fault tree method is to determine the more significant contributions to the probability of causing the undesired event, a feasible approach to probabilistic evaluation of the trees is to concentrate the effort on the dominant paths. This can be accomplished using Monte Carlo simulation, the simulation being performed on a computer using an event logic simulation program. The computer program discussed was prepared and used for quantitative evaluation of fault tree models as a tool for evaluating the functional performance of nuclear reactor protective systems in terms of system reliability and availability. (auth)

51135 (IN-1481) SEMISCALE BLOWDOWN AND EMERGENCY CORE COOLING (ECC) PROJECT TEST REPORT: TESTS 824 AND 825. Olson, D. J.; Moser, C. M.; Heiselmann, H. W. (Idaho Nuclear Corp., Idaho Falls). Jun 1971. Contract AT(10-1)-1230. 92p. Dep. NTIS.

The results of two decompression experiments (Tests 824 and 825) performed in the Semiscale Blowdown and Emergency Core Cooling (ECC) Project as part of the Water Reactor Safety Program are presented. Semiscale Tests 824 and 825 were initiated by hot-leg breaks of a system that includes both an operating loop and a vessel with simulated core, and were the first semiscale tests in which electrical power was applied to the core. The objective of these tests was to obtain experimental data relative to the effects of an initial temperature difference across the core, core heat addition, and steam generator heat removal on decompression phenomena. This objective was accomplished. The decompression test results presented include pressure, fluid and material temperatures, density, thrust, and loop strain, and derived flow rates and core heat transfer coefficients as functions of time. (7 references.) (auth)

51136 (IN-ITR-203) SEMISCALE BLOWDOWN AND EMERGENCY CORE COOLING (ECC) PROJECT TEST REPORT: TEST 821. Olson, D. J.; Whitbeck, J. F. (Idaho Nuclear Corp., Idaho Falls). Jul 1970. Contract AT(10-1)-1230. 32p. Dep. NTIS.

The results of Test 821 of the Semiscale Blowdown and Emergency Core Cooling (ECC) Project are presented. Test 821 was a hot leg blowdown from isothermal (no core heat) conditions of 2322 psia and 583°F. The blowdown nozzle was orificed to 10% (0.009 ft^2) of the pipe cross-sectional area. This test was the first test with a system configuration that includes both an operating loop and a simulated core with internals. As such, it is a reference test against which future tests to be conducted with core heat can be compared. (2 references) (auth)

51137 (JAERI-13508) STUDY ON NUCLEAR SAFETY EXPERIMENTAL PROGRAM. 1. (Japan Atomic Energy Research Inst., Tokai). Apr 1969. 30p. NTIS (U. S. Sales Only).

Research for Nuclear Reactor Safety has grown up in Japan with increasing nuclear power plants in recent years. The NSRR program (Nuclear Safety Research Reactor) is one of these activities to research reactivity transient accidents and to obtain necessary information about pulsed reactors. Since Nov. 1968, the study group for the NSRR program has examined the program from the various standpoints. Activities of the study group from Nov. 1968 to Jan. 1969 are reported. (auth) (Japan)

51138 (JAERI-13592) EUREKA: A DIGITAL PROGRAM FOR URANIUM-OXIDE FUEL, WATER COOLED, REACTOR KINETIC ANALYSIS. Ishikawa, Michio; Kuge, Yasushi; (and others) (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment). Jun 1969. 122p. NTIS (U. S. Sales Only).

EUREKA—A Digital Program for Uranium–Oxide Fuel, Water Cooled, Reactor Kinetic Analysis—was developed in order to analyze light water reactor power transient and hydraulic transients. EUREKA can handle general reactivity transient, coolant flow transient, and coolant temperature transient, but relatively severe and fast transient analysis such as accident analysis may be much more suitably handled for economic reasons. Detailed thermal-hydraulic calculations are performed in each space region of the reactor core, to obtain precise Doppler and thermal-hydraulic feedback information, fuel temperature distributions, coolant temperature profiles, pressure drop calculations, and others, even though the point kinetics theory is used to predict transient reactor power. SPERT-III E-core experimental results were used to check the EUREKA capabilities so far as these check calculations are concerned, the EUREKA shows excellent agreement with all E-core results, in transient power shapes, burst energies, feed back informations and others. All calculation results are within the SPERT-III E-core experimental uncertainties. (auth) (Japan)

51139 (NP-18987) WATER COOLED REACTOR SAFETY. An Assessment Prepared for the Committee on Reactor Safety Technology. (European Nuclear Energy Agency, Paris (France)). May 1970. 179p. Dep. NTIS (U. S. Sales Only). OECD $4,50.

Various questions considered in safety reviews of nuclear power plants of the boiling water and pressurized water types are discussed. Topical reports were prepared which attempt to define the initiation of failure modes and the possible failure sequences, to analyze the consequences of the postulated failure modes, and to assess the means of engineered prevention or mitigation of their consequences. Specific reports presented are: (1) Blowdown of Primary Systems: Thermohydraulic Effects; (2) Emergency Core Cooling; (3) Behavior of Molten Core Materials; (4) Missile Effects on Containment, Pipes, and Components; (5) Containment System Response; (6) Fission-Product Release, Transport, and Removal; (7) Reliability Analysis in Reactor Design and Safety Assessment; and (8) Super Prompt Critical Power Transients caused by Reactivity Additions in Large Reactor Cores. (H.D.R.)

51140 (RISO-M-1391) HEATING IN A REACTOR FUEL ELEMENT ROD UNDER TRANSIENT CONDITIONS. PART I. HEAT CONDUCTION PROGRAM. Abel-Larsen, H.; Larsen, M. Lolk (Danish Atomic Energy Commission, Risoe, Research Establishment). 1 Jul 1971. 118p. Dep. NTIS (U. S. Sales Only).

A computer program to solve the transient and steady-state heat conduction equation in a two-dimensional cylindrical geometry by the finite difference method is described. The program uses the alternating directional implicit (ADI) method, which is always stable, i.e., the integration is independent of time steps. The resulting three-diagonal matrix can be solved directly by a simple algorithm. Complicated heat conduction problems, as those in reactor fuel elements, can be solved. The program takes into account materials with different conductivities, heat conduction and radiation in gaps between materials and heat transfer to coolants and radiation between cooling surfaces. This is achieved by calculating effective conductivities between adjacent mesh points. The program has an operational status at the Risö Burroughs B6500 computer. Computer time requirements are moderate. A complete listing of the program is presented. (auth)

51141 KINETICS OF THE STEAM-GRAPHITE REACTION. Malinauskas, A. P. (Oak Ridge National Lab., Tenn.). Chem. Eng. Progr., Symp. Ser.; 66: No. 104, 81-93(1970).

The kinetics of the steam-graphite reaction were studied to evaluate the consequences of steam inleakage into the coolant circuit in a HTGR. An accident of this nature, as can occur from the rupture of a steam generator tube, can result in loss of core structure integrity, to the generation of potentially explosive quantities of hydrogen and carbon monoxide and, under extreme conditions, can even lead to the release of intolerable amounts of fission products. 30 references.

51142 TECHNICAL SPECIFICATIONS IN PRINCIPLE AND PRACTICE. Mann, Marvin M. (Atomic Energy Commission, Washington, D. C.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 1(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51143 SYSTEMS ANALYSIS APPROACH FOR THE DERIVATION OF TECHNICAL SPECIFICATIONS. Ranellone, R. F. (General Electric Co., San Jose, Calif.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 3(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51144 OPERATING LIMITS AND TECHNICAL SPECIFICATIONS FOR AEC CONTRACTORS. Bell, Mayhue A. (Atomic Energy Commission, Washington, D. C.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 4(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51145 LET'S PUT REACTORS, RADIATION, AND RISK IN PROPER PERSPECTIVE. Corbit, Carl D. (Douglas United Nuclear, Inc., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 38(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

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51146 OPERATIONAL TRANSIENTS IN LMFBRS AND LWRS. Van Erp, J. B.; MacFarlane, D. R. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 39(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51147 LOSS-OF-FLOW ANALYSIS FOR PRESSURIZED WATER REACTORS. Kearns, K. D.; Rossi, C. E.; Geets, J. M. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 39-40(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51148 CLADDING EMBRITTLEMENT DURING A LOSS-OF-COOLANT ACCIDENT. Hobson, D. O.; Rittenhouse, P. L. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 41(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51149 DEVELOPMENT AND IMPLEMENTATION OF EQUIPMENT MAINTENANCE STANDARDS FOR NUCLEAR REACTORS. Clement, T. M. (Douglas United Nuclear, Inc., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 45-6(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51150 PREDICTION OF INCIPIENT BOILING SUPERHEATS IN LIQUID METAL COOLED REACTOR SYSTEMS. Holtz, Robert E. (Argonne National Lab., Ill.); Fauske, Hans K.; Eggen, Donald T. Nucl. Eng. Des.; 16: No. 3, 253-65(1971).

A modeling technique which enables the calculation of the incipient boiling superheats occurring during various postulated LMFBR accidents is presented. This modeling technique is applied to various reactor systems. It is demonstrated that the system geometry plays a key role in determining the incipient boiling superheats in a flowing system. 19 references. (auth)

51151 GAS-COOLED FAST REACTOR CORE MODEL FOR THE ANALYSIS OF SEVERE ACCIDENTS, WITH APPLICABILITY TO LMFBRS. Tschirky, Hugo P. (Gulf General Atomic Co., San Diego, Calif.). Nucl. Eng. Des.; 16: No. 4, 358-68(1971).

A new fast-reactor core model has been developed which allows simulation of the behavior of a multizone core during accidental transients (loss of coolant or external reactivity insertions) leading from steady-state operation to fuel-rod failure and then to gross core damage. The model for the rod failure and for the relocation of the fuel debris is based on an interpretation of the meltdown experiments performed in the TREAT reactor. In the presented core model, the thermal response of the fuel rods is determined using a two-dimensional heat-transfer code in r-z geometry. In addition to the standard kinetics feedback relations, the reactivity effects of the gradual removal of the rod cladding are included. Taking into account the addition and removal of the heat of fusion allows the amount of fuel that resolidifies in the lower core part to be estimated. The presence of rod spacer arrangements is included as additional barriers for the debris relocation. The thermal response of the subassembly walls is calculated taking into account the contact with the high-temperature fuel as well as radiative heat transfer. 44 references. (auth)

51152 SINGLE-BUBBLE MODEL FOR SODIUM EXPULSION FROM A HEATED CHANNEL. Cronenberg, A. W. (Argonne National Lab., Ill. Northwestern Univ., Evanston, Ill.); Fauske, H. K.; Bankoff, S. G.; Eggen, D. T. Nucl. Eng. Des.; 16: No. 3, 285-93(1971).

A single-bubble model for expulsion of sodium from a reactor coolant channel due to flow blockage or loss-of-flow transients has been developed. The governing energy and momentum equations are numerically coupled throughout the voiding process. An analytic solution is obtained for the energy transport across the upper and lower liquid–vapor interfaces, while a simplified set of finite-difference equations is used to determine the heat transport within the fuel pin and across the liquid film adhering to the clad surface. Results of parametric calculations are presented for blockage transients, considering the effects of power density and fuel pin heat capacity as well as liquid superheat and the presence of liquid film on the expulsion process. (auth)

51153 HEALTH PHYSICS ASPECTS OF FAST BREEDER REACTORS. Heine, W. F.; Hart, R. S. (North American Rockwell Corp., Canoga Park, Calif.). Health Phys.; 21: No. 3, 449-52(Sep 1971).

General health physics aspects of breeder reactors will for the most part be similar to those associated with other power reactors. The specific aspects that may differ can be conveniently grouped according to segments of reactor operations. During handling of unirradiated plutonium bearing fuel, additional health physics requirements will be involved due to neutron and γ radiation levels and due to potential problems from surface contamination. During reactor operation, occasional cladding failures may result in plutonium contamination in the primary coolant, although the hazard associated with this type of contamination will probably never outweigh that of fission products. In handling of irradiated elements in the fuel replacement cycle, there is the possibility, after extended periods, for the buildup of low-level α contamination in the facility. Under certain hypothetical accident conditions where fuel vaporization could occur, plutonium could be the dominant hazard. Since at least the first commercial breeder reactors will almost certainly be liquid metal (Na) cooled, certain safety aspects of this material must be considered. (auth) (UK)

51154 NUCLEAR REACTOR INSTALLATIONS. (to Siemens Aktiengesellschaft). British Patent 1,237,390. 30 Jun 1971. Priority date 14 Oct 1967, Germany.

REACTORS, POWER—design with means for condensing coolant vapors from minor cooling system leaks (H.D.R.)

Power Conversion Systems

Refer also to abstracts 48616 and 49018.

51155 1000 Mwe LMFBR STEAM GENERATOR. Muenchow, H. O.; Armstrong, R. C. (Combustion Engineering, Inc., Windsor, Conn.). Contract AT(30-1)-4004. Combustion; 42: No. 12, 65-70(Jun 1971).

A bayonet-tube, split-bundle-design, sodium-heated steam generator is being developed for a 1000-MW(e) LMFBR power plant. It can operate as a once-through unit at full loads and as a recirculating unit at partial loads. For 950°F outlet steam temperature, presently available materials can be used to fabricate a competitively priced unit for near-term plants. Advantages are shown in ease of fabrication, maintenance, and operation. 7 references. (auth)

Research and Test Reactors

Refer also to abstracts 48763, 49579, 50193, 50430, 50591, 50593, 50594, 51014, 51026, 51041, 51042, and 51236.

51156 (CONF-710402–(Vol.2), pp I.18-21) VERSATILE NUCLEAR REACTOR FACILITY. Furr, Aaron K. (Virginia Polytechnic Inst. and State Univ., Blacksburg).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

An unusually versatile nuclear reactor facility has been planned for future construction at Virginia Polytechnic Institute and State University. The reactor design is basically a dual-core version of a TRIGA reactor in which one configuration is essentially a standard Mark III TRIGA with a full complement of beam ports and other irradiation facilities. The other configuration is similar to the annular core TRIGA currently in existence at the Sandia Corporation, modified, however, to enhance the thermal component of the flux and with an evacuated central cavity. This configuration will permit an experiment of fundamental importance to nuclear physics to be carried out, viz. a direct measurement of the neutron–neutron scattering cross section. The facility, as planned, will allow a much greater variety in the research programs than with more conventional reactors. With the interest of outside users apparent even before planning was very far advanced and with heavy utilization by the University staff, it is anticipated that the facility will be very heavily used. (auth)

51157 (CONF-710402–(Vol.3), pp IV.105-16) APPLICATIONS OF NEUTRON SOURCE REACTIVITY EFFECTS TO LOW-POWER REACTOR EXPERIMENTS. Pedretti, Edmondo (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

In Neutron sources and applications.

The kinetic equations describing the response of a low-power reactor to the step-insertion of an extraneous neutron source have been modified by explicitly introducing the reactivity effect due to the neutron source. Results of measurements performed by the RITMO reactor, in which both positive and negative source effects have been found, are reported. Reactor responses, calculated for both source effects, for various initial reactivities and insertion levels, are given and compared with responses obtained experimentally. The verification of inversion levels predicted by theory is reported with the description of methods for obtaining linear

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divergencies and for determining negative constant terms of reactor response when the reactor plus source system diverges. Development of a source-drop technique for measuring negative reactivities is described and results of control means calibration are given. Also included is a discussion of the influence that spatial effects and reactivity-dependence of kinetic parameters may have on source-drop measurements. Corrections due to source effect are specified for the source-jerk technique, for Hogan's differential method, and for the transfer function of an oscillating neutron source. (auth)

51158 (IN-ITR-201) DESIGN BASIS FOR PBF ACOUSTIC FILTERS. Feinauer, E.; Driskell, W. E. (Idaho Nuclear Corp., Idaho Falls). 1 Dec 1969. Contract AT(10-1)-1230. 219p. Dep. NTIS.

The design parameters for the in-pile tube (IPT), the high frequency acoustic filter (HFAF), the low frequency acoustic filter (LFAF), and the connecting loop piping are presented. No attempt is made to fully describe the entire experiment loop. Emphasis is placed upon the four components specifically noted and the level of detail provided for other components is intended only to permit evaluation of the interfaces. (auth)

51159 (JAERI–13606) DESIGN CALCULATION OF TEST-FUEL-ASSEMBLY OF JRR-3. Suetake, Masaharu; Sakano, Kazuo; (and others) (Japan Atomic Energy Research Inst., Tokai). Jun 1969. 41p. NTIS (U. S. Sales Only).

Design calculations of a test-fuel-assembly for changing JRR-3 core from metallic fuels to ceramic fuels are presented. (TSS) (Japan)

51160 (JAERI–13612) NEUTRON FLUX MEASUREMENT USING A SELF-POWERED DETECTOR. Tojo, Takao; Nakajima, Tadashi; (and others) (Japan Atomic Energy Research Inst., Tokai). Jun 1969. 18p. NTIS (U. S. Sales Only).

With a view toward studying utilization techniques of a self-powered detector for neutron flux measurement in a reactor core, experiments were carried out using the model RSN-202 detector (^{51}V emitter) manufactured by Reuter–Stokes Canada Ltd. In this experiment, the following measurements were done: (1) neutron flux distribution of No. 12 and No. 13 experimental holes of JRR-1; (2) leakage resistance of the detector; (3) linear relationship of the detector between its output current and the reactor power; (4) response time of the detector. It is revealed that minimum measurable neutron flux of the detector associated with a vibrating capacitor electrometer is 3×10^8 nv sec^{-1} and the leakage resistance is 3×10^{11} ohms. "Neutron Flux Distribution in the S-Pipe Experimental Hole of JRR-4 Measured with the Use of a Detector Having ^{103}Rh Emitter" are given as Appendix 1, and as Appendix 2 "Decay Curve of Detector Current of the Detector having ^{103}Rh Emitter," and as Appendix 3 "Introductory Description of a Self-Powered Detector." (auth) (Japan)

51161 (JAERI–13646) OPERATING EXPERIENCE IN JRR-2. Repair Procedures of Lowerplug and Support-Ring. Fukazawa, Kunitake (Japan Atomic Energy Research Inst., Tokai). Aug 1969. 68p. NTIS (U. S. Sales Only).

Several years ago, in JRR-2 the deformation of aluminum tubes in the lower plug inhibited routine refueling, and the heavy-water leakage at the packing of the support ring caused difficulty in the reactor operation. The lower plug and the support ring were repaired during the four months from October 1968 to January 1969. Since they were within the reactor shield, the inspection and repair of the deformation and leakage could not be done conveniently. For the former, all the 24 tubes penetrating through the heavy concrete were replaced with new tubes, and for the latter, a sealplate was welded between the support ring and reactor containment. After these repairs, JRR-2 operated with no trouble. The procedures of repairs and associated problems are described in the operating experience of JRR-2. (auth) (Japan)

51162 (JAERI–13664) BIBLIOGRAPHY ON THE USES OF RESEARCH REACTORS. Sasaki, Yoshikata (Japan Atomic Energy Research Inst., Tokai). Jul 1969. 41p. NTIS (U. S. Sales Only).

A bibliography on the uses of research reactors similar to JRR-2, –3 and –4 is presented. High flux thermal reactors are also included. The bibliography was prepared by the use of Nuclear Science Abstracts (1964–1968). (auth) (Japan)

51163 (JAERI–13671) STUDIES OF FISSION PRODUCT RELEASE IN TLG-1 IN-PILE GAS LOOP. 2. MEASUREMENT WITH Ge(Li) DETECTOR. Kitahara, Tanemichi; Shirai, Eiji; (and others) (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment). Aug 1969. 67p. NTIS (U. S. Sales Only).

Some of the results obtained on the release of fission products in TLG-1 In-Pile Gas Loop are presented. Fission products from a leaky fuel rod were analyzed by the gamma-ray spectra measured with a Ge(Li) detector. Nuclides representing each photopeak of the gamma-ray spectrum were individually identified, especially short lived fission gases were easily detected because of the short travelling time from the irradiation position to the counting device. The identified nuclides were all gaseous fission products or their daughters and no iodine was detected. The behavior of fission products released in the in-pile loop is discussed. It appears that the behavior of fission products release depends on the preparation of leaky fuel. Ge(Li) detector is effective for the accurate measurements of fission product release from leaky fuel. The measuring methods with the Ge(Li) detectors are discussed. (auth) (Japan)

51164 (JAERI–13689) OPERATION MANUAL FOR JRR-3: THE REACTOR. Ishii, Toshio; Takada, Hikaru; (and others) (Japan Atomic Energy Research Inst., Tokai). Aug 1969. 71p. NTIS (U. S. Sales Only).

The manual is to aid JRR-3 to operate the reactor both safety and properly. It includes the procedures of operation, check and recording of the reactor, and also measures taken at the time of abnormalities. (auth) (Japan)

51165 (JAERI–13690) OPERATION MANUAL FOR JRR-3: THE AUXILIARY FACILITIES. Sekiguchi, Kazuo; Mitsui, Toshihiro (Japan Atomic Energy Research Inst., Tokai). Aug 1969. 73p. NTIS (U. S. Sales Only).

The manual is for operation of the auxiliary facilities of JRR-3, such as those of utilities, both safely and properly. It includes the procedures of operation and recording of the facilities, and also measures taken at the time of abnormalities. (auth) (Japan)

51166 (JAERI–13715) OPERATION MANUAL FOR JRR-4: THE REACTOR. (Japan Atomic Energy Research Inst., Tokai). Sep 1969. 22p. NTIS (U. S. Sales Only).

The manual is to aid JRR-4 operators to operate the reactor both safely and properly. It includes the procedures of operation, check and recording of the reactor, and also measures taken at the time of abnormalities. (auth) (Japan)

51167 (JAERI–13716) OPERATION MANUAL FOR JRR-2: THE REACTOR. (Japan Atomic Energy Research Inst., Tokai). Sep 1969. 56p. NTIS (U. S. Sales Only).

The manual is to aid JRR-2 operators to operate the reactor both safely and properly. It includes the procedures of operation, check and recording of the reactor, and also measures taken at the time of abnormalities. (auth) (Japan)

51168 (JAERI–13730) OPERATION MANUAL FOR JRR-4: THE AUXILIARY FACILITIES. Sekiguchi, Kazuo; Shibata, Tokio (Japan Atomic Energy Research Inst., Tokai). Sep 1969. 34p. NTIS (U. S. Sales Only).

The manual is for operation of the auxiliary facilities of JRR-4, such as those of utilities. It includes the procedures of operation, check and recording of the facilities, and also measures taken at the time of abnormalities. (auth) (Japan)

51169 (JAERI–13753) IMPROVEMENT ON THE REACTOR INSTRUMENTATION OF THE JRR-2, JRR-3, AND JRR-4. Kinbara, Setsuro; Tsuchiya, Toshio; (and others) (Japan Atomic Energy Research Inst., Tokai). Oct 1969. 178p. NTIS (U. S. Sales Only).

The improved reactor instrumentation of the JRR-2, JRR-3 and JRR-4 is described from the design and fabrication standpoints. Most of main part of these reactor instruments such as Linear N meter and Log N period meter are included in the improved reactor instrumentation. Main improved points are use of the modular system and use of the integrated circuits as main circuit elements. A general description on the improved reactor instrumentation and circuit configuration and the function and characteristics of each unit and set of instruments are presented. (auth) (Japan)

51170 (JAERI-Memo–4343) TECHNICAL REPORT FOR THE RESEARCH REACTORS AND THE HOT LABORATORY, APRIL 1, 1969–MARCH 31, 1970. (Japan Atomic Energy Research Inst., Tokyo). Feb 1971. 250p. (In Japanese). Dep. NTIS (U. S. Sales Only).

The Division of Research Reactor Operation is in charge of four research reactors, JRR-1, JRR-2, JRR-3 and JRR-4, and the Hot Laboratory for the post-irradiation tests of reactor fuels and materials. The following activities are described; operation and maintenance, material irradiation, fuel management, water and gas treatments, radiation monitoring, and joint research. Problems and the countermeasures taken are described together with various achievements, including measurements on the thermal

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conductivity of VIPAC UO_2 fuels and characteristic measurements of the experimental holes for the development of irradiation techniques. During the year, JRR-1 was deactivated after 11 years of operation. Uranium leakage into the core from failed JRR-3 fuels in 1968 was estimated and the failed fuel detection system was improved. In 1969, laboratory experiments on the D_2O decontamination were made. Results of the experiments and development of the possible decontamination techniques are reported. The fuel in JRR-2 was increased in ^{235}U amount. In JRR-4, a reactor physics analysis and a safety analysis were made on the modification of the reactor from the viewpoint of increasing the utilization and feasibility of operation. JRR-2 and JRR-4 were both operated with no trouble during this reporting period. The activities in the Hot Laboratory in the year were JAPCO fuel monitoring, joint study of UO_2 fuel, and post-irradiation tests of JPDR-2F and DFR irradiated materials. (auth) (Japan)

51171 (KFK-1356) FEASIBILITY STUDY ON THE FAST HIGH FLUX TEST REACTOR FR 3. Fischer, M. (Kernforschungszentrum, Karlsruhe (West Germany)). Mar 1971. 537p. (In German). Dep. NTIS (U. S. Sales Only).

A cooperative effort with regard to a design and feasibility study for a fast high-flux test reactor FR 3 is described. The dominant objectives of this test facility are to provide irradiation capability for basic research, as well as large test loops for systematic and controlled testing of fuels, structural materials, and complete fuel elements. The main tasks of the study were to work out fundamental technical solutions for a test reactor with very high fast neutron flux and large test loop capability and to estimate the investment and operating costs of such a facility. The construction of FR 3 is considered feasible on the basis of the breeder prototype technology without excessive additional R and D work. (auth)

51172 (LIB/Trans-375) OSIRIS. Translated by W. Buykx (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from Bull. Inform. Sci. Tech. (Paris); No. 111, 1-84(Jan 1967). 85p. Dep. NTIS (U. S. Sales Only).

A description is presented of the swimming-pool pile Osiris, a 50-MW high flux reactor designed particularly for the irradiation of structural materials for future power reactors, and characterized by easy access to the core. The design of the reactor is described along with its annexes. The neutron characteristics, cooling system, control methods, treatment of measurements and signals are described, and constructional and safety problems are reviewed. The possibilities available to researchers are indicated. Iris, a low-power mock-up of Osiris, is also described. (tr-auth)

51173 RELEASE AND MIGRATION OF IRRADIATED STAINLESS STEEL IN FLOWING SODIUM. Brehm, W. F.; Kovacevich, E. A.; Shannon, D. W. (Battelle-Northwest, Richland, Wash.). Chem. Eng. Progr., Symp. Ser.; 66: No. 104, 116-23(1970).

Transport and deposition of radioisotopes released to flowing sodium from corrosion of irradiated stainless steel was studied. Quantitative measurements of deposition can be made with sensitive counting techniques. The results of the study indicate that ^{51}Cr and ^{60}Cr are transported slowly and do not rapidly migrate to lower temperature regions of loop systems. However, ^{54}Mn is released in larger quantities to deposit throughout the test loops. Preferential deposition sites are immediately downstream from the source, at minimum temperature locations, and in oxygen cold traps. Deposited ^{54}Mn migrated rapidly to the cold trap; deposited ^{51}Cr and ^{60}Cr migrated slowly. The rapid transport of large amounts of ^{54}Mn to low temperature locations can create serious problems for reactor maintenance. Work is continuing to better define the factors which affect this deposition, and to develop methods for trapping out radioisotopes in preselected shielded low maintenance locations. 10 references. (auth)

51174 ANOMALIES IN THE ANALYSIS OF AIR-SPACED ARRAYS. Gutman, Thomas (Combustion Engineering, Inc., Windsor, Conn.). Nucl. Technol.: 12: No. 2, 162-72(Oct 1971).

The phenomenon of interaction between air spaced, subcritical units of fissile materials is investigated using Monte Carlo calculations. Studies of array interactions using Monte Carlo codes indicate that certain techniques of array analysis which proceed from the extension of available experimental data may yield nonconservative results. These areas of apparent nonconservatism cannot be verified from studies of experimental data, and may be subject to further question in view of inconsistencies which have been observed among some of the Monte Carlo calculated arrays. Studies of experimental and calculated array data show the differing conclusions which may be developed and point out the need for future work. (11 references) (auth)

51175 EXPERIMENTAL MEASUREMENT OF GAMMA HEAT IN THE HIGH FLUX ISOTOPE REACTOR. Senn, R. L.; Mixon, W. R. (Oak Ridge National Lab., Tenn.). Nucl. Technol.: 12: No. 2, 235-40(Oct 1971).

The combined neutronic heating from gamma and neutron attenuation was measured in stainless steel and graphite samples irradiated in the High Flux Isotope Reactor. Measurements were made at intervals during a reactor fuel cycle and at various elevations with respect to the reactor core. Peak energy depositions measured were 13.6 W/g in graphite and 16.6 W/g in stainless steel. The experiments illustrated the importance of considering local environment, especially nearby radiation sources and sinks, as well as the geometry of the material, when estimating energy deposition rates. (auth)

51176 SAFETY CONSIDERATIONS FOR RECHARGE OF THOR SPENT FUELS IN ZPRL. Weng, P. S. (National Tsing Hua Univ., Hsinchu, Taiwan). Nucl. Technol.: 12: No. 2, 241-2(Oct 1971).

A method was developed to ensure that no fuel rupture had taken place while spent fuels of MTR type were transported from one reactor to another for recharge. Placing a spent fuel element in an aluminum vessel located in a reactor pool and checking its water activity after at least 24-hour circulation provides a simple means for the determination of fuel rupture. (auth)

51177 RESEARCH REACTOR EXPERIENCE WITH TECHNICAL SPECIFICATIONS. Wyman, M. E.; Beck, G. P. (Univ. of Ill., Urbana). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 1-2(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51178 DETECTING LEAKS IN PLATE-TYPE ELEMENTS. Clark, R. H.; Cure III, J. W. (Babcock and Wilcox, Lynchburg, Va.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 5-6(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51179 REACTIVITY CALIBRATION OF A FAST PULSE REACTOR. Kazi, A. H.; Dubyoski, H. G.; Dickinson, R. W. (Army Aberdeen Research and Development Center, Aberdeen Proving Ground, Md.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 7-8(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51180 OPERATING EXPERIENCE AT THE UNIVERSITY OF MISSOURI RESEARCH REACTOR. Cox, E. L.; Alger, D. M. (Univ. of Missouri Research Reactor, Columbia). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 19(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51181 UNION CARBIDE CORPORATION REACTOR SYSTEMS FOLLOWING TEN YEARS OF CONTINUOUS OPERATION. Bordoni, Maurice E. (Union Carbide Corp., Tuxedo, N. Y.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 19-20(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51182 BERYLLIUM BEHAVIOR IN THE NASA PLUM BROOK REACTOR. Hasse, Robert A. (Lewis Research Center, Sandusky, Ohio). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 20(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51183 TEST REACTOR OPERATING EXPERIENCE WITH FAILURE-PRONE FUEL. Hilker, H. R.; Fogarty, F. C. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 20-2(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51184 REACTOR IN-SERVICE INSPECTION: CASE STUDY. Fogarty, F. C. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 22(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51185 PRECISE TIMING SYSTEM FOR PNEUMATICALLY TRANSFERRED SAMPLES. Helfer, Paul G. (Geological Survey, Denver). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 22-3(1971)

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51186 NEUTRON FLUX SPECTRUM IN THE HFIR HYDRAULIC TUBE. Swanks, J. H.; Kam, F. B. K. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 23-4(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

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51187 FALSE INDICATION OF FUEL ELEMENT FAILURE AT A POOL REACTOR. Bates, E. F.; Sandel, P. S.; Randall, J. D. (Texas A and M Univ., College Station). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 24(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51188 MODIFICATION OF A BSR-MTR-TYPE GRID PLATE TO ACCEPT FUELED FOLLOWERS. Feltz, Donald E.; Mason, Paul M.; Randall, John D. (Texas A and M Univ., College Station). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 25(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51189 IMPLEMENTATION OF A RIGOROUS MANAGEMENT CONTROL SYSTEM FOR REACTOR OPERATION. McMillan, F. L.; Burdge, L. F.; Sorenson, R. E. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 45(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51190 TEST REACTOR OPERATING CREW TRAINING. Davis, J. N. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 48(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51191 ALRR TRAINING/RETRAINING PROGRAM. Gurganus, Edward K. (Ames Lab., Iowa). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 48-9(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51192 OPERATION AND PLANT CHANGES AT CP-5 REQUIRED BY THE POSITIVE LIGHT-WATER-REPLACEMENT REACTIVITY COEFFICIENT. Talboy, J. H.; Banfield, T. V.; Kelber, C. N. (Argonne National Lab., Ill;). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 58(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51193 FLUX MEASUREMENT OF EPITHERMAL AND FAST NEUTRONS IN THE VERTICAL CHANNEL OF REACTOR IRT-2000. Lomonosov, I. I.; Soroka, A. V.; Firsov, E. I.; Cherenda, N. G. (Inst. of Physics, Minsk). Vєstsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 4, 112-16(1970). (In Belorussian).

The epithermal and fast neutron fluxes in a vertical channel of the IRT-2000 were measured using resonance and threshold foil activation detectors. Induced activity was measured using a 4π gamma spectrometer. The differential epithermal spectra and the integral fast spectra are presented. 10 references. (tr-auth)

51194 SUBSTITUTION EXPERIMENTS IN THE FAST EXPERIMENTAL REACTOR CORAL-1. Gutierrez-Bernal, R.; Caro, R.; Mayquez, E. Rodriguez. Energ. Nucl. (Madrid); 14: No. 68, 464-9(Nov-Dec 1970). (In Spanish).

The experimental facility developed to measure the reactivity coefficients of graphite, Al, Fe, and Pb by means of substitution techniques in the fast power reactor CORAL-1 is described. The measurements are interpreted by use of the first order perturbation theory in the one-group neutron theory. The agreement between the experimental and theoretical results are very good with the exception of graphite. 8 references. (tr-auth)

Rocket and Space Reactors

Refer also to abstracts 48645, 49343, 49411, 49574, and 49577.

51195 ESTIMATES OF FUEL CONTAINMENT IN A COAXIAL FLOW GAS-CORE NUCLEAR ROCKET. Putre, Henry A. (Lewis Research Center, Cleveland). Nucl. Technol.; 12: No. 2, 209-17 (Oct 1971).

The main problem for fluid mechanics analysis in the rocket engine is that of predicting the contained fuel mass for various propellant-to-fuel flow ratios. The analysis described predicts a dimensionless measure of fuel mass, called the fuel volume fraction. This analysis uses a coaxial free-jet computer code, and eddy viscosity equations that were developed for this code. The calculated variation of volume fraction with flow ratios, fuel radius, and fluid density is shown to be in general agreement with previous data. The analysis and the data predict that the required fuel volume fraction of 0.20 at the flow ratio of 50 can be obtained at a density ratio of 1.0 and a radius ratio of 0.7. (auth)

51196 EVALUATION OF CRITICAL MASS FOR OPEN-CYCLE GAS-CORE ROCKET REACTORS. Hyland, Robert E. (Lewis Research Center, Cleveland). Nucl. Technol.; 12: No. 2, 152-61 (Oct 1971).

A nuclear analysis using transport theory was made of an open-cycle gas-core reactor for assumed operating conditions. Calculations were made for cavity diameters from 2.44 to 4.88 meters, for hydrogen (cavity) bypass variation from 0 to 99 percent, for reflector thickness from 0.61 to 1.07 meters, and for both isotopes ^{235}U and ^{233}U as fuel. For these configurations the results indicated that ^{233}U and some bypass hydrogen may be necessary to keep critical mass levels low enough to give system pressures of less than 1000 atmospheres. (17 references) (auth)

51197 AEROSPACE NUCLEAR APPLICATIONS PROCEEDINGS. American Nuclear Society 1970 Topical Meeting, Huntsville, Alabama, April 28–30, 1970. Huntsville, Ala.; American Nuclear Society (1970). 571p. (CONF-700441).

The development programs for space vehicle nuclear propulsion and nuclear power systems are reviewed. Separate abstracts are presented for each of the 19 papers included. (D.C.C.)

For abstracts of individual papers see: 48746–48749 and 51198–51212.

51198 NERVA REACTORS. Johnson, M. T. (Westinghouse Astronuclear Lab., Pittsburgh). pp 4-39 of Aerospace Nuclear Applications Proceedings. Huntsville, Ala.; American Nuclear Society (1970).

From Meeting on aerospace nuclear applications; Huntsville, Ala. (28 Apr 1970). See CONF-700441.

The history, current activities and future development of the NERVA nuclear rocket reactor are reviewed. Engineering solutions to problems encountered during the NRX and XE Series of technology tests from the inception of the NERVA program to the present are discussed. A description of the status of the present performance requirements, and the systems engineering approach used to integrate these requirements into plans and specifications for the development phase of the flight reactor are presented. The future estimated performance capabilities of the NERVA reactor are described. A discussion of the technological problems and potential solutions that are anticipated prior to achieving a qualified flight reactor is provided. (auth)

51199 NERVA DEVELOPMENT APPROACH. Wetmore, William O. (Aerojet-General Corp., Downey, Calif.). pp 40-70 of Aerospace Nuclear Applications Proceedings. Huntsville, Ala.; American Nuclear Society (1970).

From Meeting on aerospace nuclear applications; Huntsville, Ala. (28 Apr 1970). See CONF-700441.

The relatively high cost of testing a nuclear rocket engine makes it impractical to establish the desired level of confidence in the engine's reliability by testing large numbers of complete engines, as is the standard procedure for other systems. Instead, rigorous thermal, structural, and performance analyses are conducted on individual components and subsystems. The results of these analyses are then verified by testing. Reliability information and performance data generated in this component program are then combined analytically so the performance of the complete engine can be accurately predicted. Digital and analog analytical models of the engine system have been constructed. These models are used and upgraded during the development program, and, prior to every test, a detailed prediction of the performance of the engine system and of every subsystem and component is made. In this way, engineers conducting the tests have prior knowledge of expected behavior, and, if any component deviates from its design operating condition, they can take corrective action to prevent damage to other parts of the system. An operation of this type significantly reduces development cost by minimizing the amount of hardware required to achieve test objectives. This technique has been well verified in the NRX reactor tests and in the NRX/EST and XE engine test program. (auth)

51200 NUCLEAR ROCKET APPLICATIONS. Gronich, S. (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). pp 72-98 of Aerospace Nuclear Applications Proceedings. Huntsville, Ala.; American Nuclear Society (1970).

From Meeting on aerospace nuclear applications; Huntsville, Ala. (28 Apr 1970). See CONF-700441.

Nuclear rockets have been considered as the next evolutionary space propulsion system. Performance, mission requirements, and development approaches will be described for the nuclear rocket consistent with alternate mission models. The utility of a nuclear third stage on Saturn V for unmanned outer planet probes, a Mars Surface Sample Return, and lunar and synchronous logistics will be shown. Evolution of this system to perform manned

planetary, and lunar and synchronous orbit shuttle missions will also be discussed. 14 references. (auth)

51201 ADVANCED NUCLEAR ROCKET TECHNOLOGY. Kirk, William L. (Los Alamos Scientific Lab., N. Mex.). pp 102-7 of Aerospace Nuclear Applications Proceedings. Huntsville, Ala.; American Nuclear Society (1970).

From Meeting on aerospace nuclear applications; Huntsville, Ala. (28 Apr 1970). See CONF-700441.

There are three major areas in which the performance of solid-core nuclear engines may be improved by advances in technology. These are: specific impulse, weight, and lifetime. A major increase in Isp can be obtained only by increasing the reactor exit gas temperature which in turn depends on the development of reactor core materials which can operate at higher temperatures or better utilization of current materials by improving the core heat transfer geometry. UC–ZrC–C composites and solid solution UC–ZrC appear to be the most promising materials for higher temperature operation. Both are under development. Recent studies on alternative core geometries have not disclosed any practical geometry which will improve core heat transfer. There are numerous engine subsystems in which weight savings might be realized, but the most basic approach is increasing the power density (power/unit volume) of the reactor core. Unfortunately, the new core materials mentioned are not only heavier but seem to be more limited in thermal stress capability than graphite-matrix fuel. It may be possible to improve their capability by altering the reactor design so that thermal stress cracks or breaks are tolerable. Such core designs are being studied. At present, it seems that the useful life of a nuclear engine depends mainly on the lifetime of the core. The core and, particularly, the fuel, lifetime is partially dependent on the operating temperature level so that lower Isp leads to longer life. There are other components of the core, whose life is not directly affected by the operating temperature, for example, the currently used insulating material. The life of these components can be extended only by substantial design changes. Two new reactors, called Pewee and nuclear furnace, are being used to test fuel elements and other core components more quickly and cheaply than is possible with full-scale NERVA tests. (auth)

51202 GAS CORE NUCLEAR ROCKETS. McLafferty, George H. (United Aircraft Corp., East Hartford, Conn.). pp 108-37 of Aerospace Nuclear Applications Proceedings. Huntsville, Ala.; American Nuclear Society (1970).

From Meeting on aerospace nuclear applications; Huntsville, Ala. (28 Apr 1970). See CONF-700441.

Recent advances in technologies having application to the nuclear light bulb and the coaxial-flow gaseous core nuclear rocket reactors are reviewed. Both proposed reactors are based on the transfer of energy by thermal radiation from gaseous nuclear fuel to seeded hydrogen propellant. The coaxial-flow reactor is an open-cycle engine, while the nuclear light bulb reactor employs an internally cooled transparent wall between the fissioning gas and the hydrogen propellant. Reference configurations for both engines are calculated to provide a specific impulse of approximately 1800 sec and a thrust-to-weight ratio of approximately 1.4. Two recently investigated flow configurations show promise of improving the containment of the gaseous nuclear fuel in a coaxial-flow engine. These configurations involve the use of foam inlets at the gas entrance to reduce the turbulence in the flow, and the use of a spherical rather than a cylindrical cavity. Substantial progress has been made in simulating the thermal environment of a nuclear light bulb engine during tests in r-f induction-heated plasmas. During these tests, 216 kW has been deposited in an ellipsoidal plasma having dimensions of 2.0 by 0.8 in.; of this, 156 kW was radiated from the plasma. The radiant flux at the surface of the plasma was 36 kW/in.^{2} (236 kW/cm^2; black-body radiation at a temperature of 10,200 R). In addition, transparent-wall models having wall thicknesses of 0.005 in. have been tested adjacent to the r-f heated plasma. Results are also presented relative to nuclear radiation coloration of transparent walls, engine critical mass, and engine controllability. An outline of possible phases in a program leading to the development of a full-scale engine of either the coaxial-flow or nuclear-light-bulb type is also presented. 29 references. (auth)

51203 OPERATIONAL SAFETY OF THE NUCLEAR ROCKET. Gavigan, Francis X. (Atomic Energy Commission, Washington, D. C.). pp 138-50 of Aerospace Nuclear Applications Proceedings. Huntsville, Ala.; American Nuclear Society (1970).

From Meeting on aerospace nuclear applications; Huntsville, Ala. (28 Apr 1970). See CONF-700441.

One of the missions for the Reusable Nuclear Stage requires orbit-to-orbit transportation of men and materials. Operational safety problems associated with these operations are explored. A description is given of the results of estimates of doses to astronauts and other personnel of other spacecraft from the nuclear rocket plume and directly from the reactor. Features which can be utilized to achieve safe operation in the engine and the stage are discussed. The inherent ability of the nuclear rocket to continue to operate with the core or engine in a degraded condition is discussed. Techniques to be used to capitalize on this ability by designing into the nuclear rocket the capability to operate in a degraded condition after a malfunction has occurred so that men and materials can be safely handled are described. Safety logic analysis techniques are described as well as the methods to be used to assure interaction of flight safety and design personnel. The approach to reliability to be utilized for the nuclear rocket is discussed as well as its contribution to achievement of safe operation. Contingency planning is described with some discussion of safeguards which are being considered or investigated. 6 references. (auth)

51204 PROTECTION GUIDES FOR COMBINED SPACE AND NUCLEAR RADIATION EXPOSURE. Langham, Wright H. (Los Alamos Scientific Lab., N. Mex.). pp 152-62 of Aerospace Nuclear Applications Proceedings. Huntsville, Ala.; American Nuclear Society (1970).

From Meeting on aerospace nuclear applications; Huntsville, Ala. (28 Apr 1970). See CONF-700441.

Manned space operations contemplated during the next 10 to 20 years will involve longer missions than the Apollo series, will require more flight personnel, and will employ nuclear systems both for propulsion and on-board power requirements. Because of the combined levels of nuclear and space radiation exposure, it appears impractical to conduct such operations within radiation protection limits established for terrestrial occupational exposure. Radiation protection criteria for current vehicle design and mission planning studies are badly needed but, if given as specific numbers, imply evaluation of aims and goals of the nation's manned space program in terms of human risk. To provide guidance without making risk-versus-gain judgments, the concept of a "reference" risk is proposed. The reference risk may be used as a guide for operations and missions of different types, different risk-versus-gain evaluations, and different degrees of complexity or sophistication by multiplying the reference risk exposure level (in Rem) by X, with X restricted within limits of 0 and 2. It is proposed that an approximate doubling of the natural risk of death from malignant disease in the U. S. white male population over the 20-year period (age 35 to 55) be adopted as a reference risk. On the basis of current knowledge, this risk may be associated with a protracted exposure of ~400 Rem at the mean depth of the functional bone marrow (5 cm). To assure that exposure is protracted and that intolerable early and late radiation effects in other critical tissues are not encountered, additional constraints should be placed on 1-year, quarterly, and 30-day exposure accumulation rates and on the ratio of exposure at 5 cm to exposure at the effective depth of the basal layer of the skin and the ocular lens. 11 references. (auth)

51205 NUCLEAR ELECTROMAGNETIC PROPULSION. Stratton, T. F. (Los Alamos Scientific Lab., N. Mex.). pp 204-25 of Aerospace Nuclear Applications Proceedings. Huntsville, Ala.; American Nuclear Society (1970).

From Meeting on aerospace nuclear applications; Huntsville, Ala. (28 Apr 1970). See CONF-700441.

Propulsion of spacecraft by a motor system comprising a magnetic plasma accelerator and a nuclear electric generator appears to be an attractive, and perhaps necessary, concept for manned interplanetary exploration. Such a motor system exists only as a concept, however, lacking both motor and power supply, and finds itself competing for recognition with other advanced systems. Magnetically dominated thrust motors, in comparison with electrostatic engines, exhibit greater thrust density, freedom of choice of expellent, and possibly greater efficiency for specific impulses which are optimum for power limited interplanetary transits. Experimental and theoretical work is concentrated on low power applied axial magnetic field arcs, high power (pulsed) self field arcs, and preliminary studies of intermediate power, steady, self field arcs. Among the fundamental properties which serve as a guide to the experimental programs are that the thrust is related to the magnetic pressure; that the magnetic field must be strong enough to give the ions of the plasma a gyro-radius of the same order as the radial dimension of the arc; and that the ions carry an appreciable fraction of the arc current. It has been demonstrated that plasma velocities of interest for propulsion are attainable in steady plasma accelerators and the focus of future work must now shift to the problem of achieving the greatest possible efficiency for conversion of input electrical power into exhaust kinetic flow. 10 references. (auth)

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51206 NUCLEAR ELECTRIC PROPULSION. Casal, Federico G. (Office of Advanced Research and Tech., Moffett Field, Calif.). pp 226-40 of Aerospace Nuclear Applications Proceedings. Huntsville, Ala.; American Nuclear Society (1970).

From Meeting on aerospace nuclear applications; Huntsville, Ala. (28 Apr 1970). See CONF-700441.

A status report on the reevaluation of the application of nuclear electric propulsion in space missions is presented. Analytical procedures take into account mission-dependent parameters, powerplant-dependent characteristics and some basic cost aspects of nuclear electric propulsion systems. Special emphasis is given to the effects of uncertainties in systems characteristics and of cost aspects upon the results of the evaluation. The problem of selecting a common design for a multi-mission powerplant is also considered and tentative solutions to this particular problem are outlined. 12 references. (auth)

51207 REACTOR FOR NUCLEAR EXTENDED RANGE AIRCRAFT. Werle, Jack E. (Westinghouse Astronuclear Lab., Pittsburgh); Orazio, Fred D. Sr. pp 242-73 of Aerospace Nuclear Applications Proceedings. Huntsville, Ala.; American Nuclear Society (1970).

From Meeting on aerospace nuclear applications; Huntsville, Ala. (28 Apr 1970). See CONF-700441.

The technological advancements of nuclear reactors for airborne purposes are discussed, along with the highlights of preliminary aircraft designs incorporating a high temperature, liquid metal cooled reactor. A discussion of some of the most critical problem areas that must be solved for the successful development of a nuclear-powered, long endurance, long range aircraft is presented. (auth)

51208 TECHNOLOGY FOR NUCLEAR DYNAMIC SPACE POWER SYSTEMS. English, Robert E. (Lewis Research Center, Cleveland). pp 280-300 of Aerospace Nuclear Applications Proceedings. Huntsville, Ala.; American Nuclear Society (1970). (NASA-TM-X-52771).

From Meeting on aerospace nuclear applications; Huntsville, Ala. (28 Apr 1970). See CONF-700441.

For use with nuclear energy sources, the following types of dynamic power are being investigated for use in space: Brayton and mercury, organic, and potassium Rankine. The state of development of these systems is described and their salient characteristics are discussed. For the advanced systems, the supporting technology is briefly reviewed. 10 references. (auth)

51209 ZrH REACTOR AND THERMOELECTRIC CONVERSION SYSTEMS. Wilson, R. F. (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-701. pp 302-39 of Aerospace Nuclear Applications Proceedings. Huntsville, Ala.; American Nuclear Society (1970).

From Meeting on aerospace nuclear applications; Huntsville, Ala. (28 Apr 1970). See CONF-700441.

The ZrH reactor is a heat source capable of operating with all static and dynamic power conversion systems currently of interest for space application. With static power conversion systems electrical powers exceeding 50 kW(e) can be achieved, and dynamic power conversion systems can provide over 100 kW(e). The reactor program has completed 5 reactor tests, including the only flight test of a space reactor power system—SNAP 10A, and a 600 kW(t) prototype reactor, originally designed for unmanned application, has recently been operated. The program is currently directed toward incorporating the latest operational data intc a man-rated reactor suitable for use on an orbiting space station. In parallel with the reactor program is development of a high power thermoelectric conversion system. The data support thermoelectric system efficiencies of 4½% for 20,000 hours life. Test modules have been on endurance test for over 28,000 hours. The technology status of the reactor and thermoelectric work is reviewed and typical system performance applicable to a large manned space station is discussed. (auth)

51210 THERMIONIC REACTORS. Grover, George M. (Los Alamos Scientific Lab., N. Mex.). pp 340-56 of Aerospace Nuclear Applications Proceedings. Huntsville, Ala.; American Nuclear Society (1970).

From Meeting on aerospace nuclear applications; Huntsville, Ala. (28 Apr 1970). See CONF-700441.

Thermionic reactors are being developed for auxiliary power and electric-propulsion applications in space. The in-core thermionic conversion system appears to offer the widest range of application and is receiving the greatest attention. The status of thermionic converter technology in the United States and abroad is reviewed with emphasis on thermionic diodes for in-core reactors. Converter designs and testing results are summarized. The various thermionic reactor concepts that have been studied are reviewed, with a discussion of the technical strengths and weaknesses of each concept. The status of the reactor development program is discussed. (auth)

51211 NUCLEAR SAFETY OF SPACE NUCLEAR POWER SYSTEMS. Dix, George P. (Atomic Energy Commission, Washington, D. C.). pp 358-86 of Aerospace Nuclear Applications Proceedings. Huntsville, Ala.; American Nuclear Society (1970).

From Meeting on aerospace nuclear applications; Huntsville, Ala. (28 Apr 1970). See CONF-700441.

Discussion of the nuclear safety experience gained in the last decade is presented. The use of this experience for the design and operations of space nuclear power systems in the next decade is analyzed. The SNAP 3, 9, 10A, 19, and 27 flights occurring between 1960–1970 are summarized, including the pre-flight hardware development and evaluation experience, launch vehicle considerations, and the operational safety experience with contingency planning and two launch aborts (SNAP 9 and 19). The evolution of the safety philosophy and design approach is traced from SNAP 3 to the TRANSIT and PIONEER nuclear power systems currently under development. The evolution of fuel forms and heat sources is discussed and a new concept of fuel immobilization is presented. The current space nuclear safety approach for orientation of potential users of space nuclear power supplies is summarized. 9 references. (auth)

51212 NUCLEAR POWER FOR MANNED ORBITING SPACE STATIONS. Slone, Henry O.; Shure, Lloyd I. (Lewis Research Center, Cleveland). pp 390-407 of Aerospace Nuclear Applications Proceedings. Huntsville, Ala.; American Nuclear Society (1970). (NASA-TM-X-52774).

From Meeting on aerospace nuclear applications; Huntsville, Ala. (28 Apr 1970). See CONF-700441.

The impact of using nuclear (reactor and isotope) power systems on Space Station and Space Base is discussed, and candidate nuclear power systems are compared. Much of the information presented is derived from the current NASA Phase-B Space Station studies. 4 references. (auth)

Process Heat and Desalination Reactors

Refer also to abstract 49205.

51213 (JUL-745-RG) ENERGY PROGNOSIS FOR THE FEDERAL REPUBLIC OF GERMANY FROM THE VIEWPOINT OF INTRODUCTION OF NUCLEAR HEAT FOR VAPORIZATION OF FOSSIL RAW MATERIALS. Kugeler, Manfred (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Mar 1971. 79p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Technische Hochschule, Aachen, Ger.

Application of nuclear energy is discussed with respect to its effects on processes using fossil fuel. Although water reactors, producing steam of about 300°C, can already be useful in the chemical industry and for refineries, the high-temperature reactor offers manyfold opportunities with respect to the production of gases and olefins. These possibilities are discussed for the gasification of coal, the transformation of natural gas into hydrogen or other synthesized gases, and the cracking of crude oil into hydrogen olefins and gasoline. Because of the fact that the transformation unit works with helium in a closed circuit, air pollution is minimal. This point is considered more important than economic considerations. Further possibilities are discussed in regard to reduction of iron ore, gasoline production from coal, ammonium synthesis, and methanol fabrication. (81 references) (H.B.G.)

51214 (ORNL-NDIC-10) INDEXED BIBLIOGRAPHY OF NUCLEAR DESALINATION LITERATURE-6. Johnsson, K. O. (Oak Ridge National Lab., Tenn.). Sep 1971. Contract W-7405-eng-26. 91p. Dep. NTIS.

Abstracts are given for approximately 300 published articles related to the desalination of seawater. The body of the report is a copy of information stored in a computerized storage and retrieval system for the Nuclear Desalination Information Center (NDIC) at the Oak Ridge National Laboratory. The abstracts are grouped in nine categories (and repeated if they fall into more than one category). An author index and a key-word index to the articles referenced are provided. (auth)

51215 REPORT OF THE THIRD INTERNATIONAL SYMPOSIUM ON DESALINATION OF SEA WATER. Ortega Martinez, Juan Miguel. Energ. Nucl. (Madrid); 14: No. 68, 501-6(Nov-Dec 1970). (In Spanish).

The most important studies on the distillation procedures for the desalination of sea water are analyzed. (J.S.R.)

Marine and Portable Power Reactors

Refer also to abstracts 48836, 48866, and 49394.

51216 RADIOCHEMICAL MONITORING AND EVALUATION OF OPERATING CORES UNDER THE ARMY NUCLEAR POWER PROGRAM. Abriss, Arnold; Turovlin, Bernard (Army Engineer Reactors Group, Ft. Belvoir, Va.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 8(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51217 IMPLICATIONS OF THE DIFFERENCES IN NEUTRON SPECTRA PREDICTED FOR REACTOR PRESSURE VESSEL WALLS BY TRANSPORT AND THE P1MG CODES. Serpan, Charles Z. Jr. (Naval Research Lab., Washington, D. C.). Nucl. Eng. Des.; 16: No. 1, 24-34(May 1971).

Neutron-energy spectra were calculated for the interface between the vessel wall and cladding of the Army SM-1A Reactor pressure vessel using the transport theory code Program S and the diffusion code P1MG. Different sets of basic nuclear data and microscopic cross sections were used for the two calculations. Spectra were normalized to the same amount of activation in an iron, neutron flux detector. The transport code predicted a higher flux of neutrons in the energy groups between 6 and 10 MeV resulting in a lower overall intensity for the transport theory spectrum versus the P1MG spectrum. This was found to be consistent with the predictions of two transport codes versus the P1MG code for the PM-2A reactor vessel wall and for a simulated reactor vessel wall experiment. Such divergence of results for a given reactor using two different code analysis techniques raises important questions as to their usually unqualified acceptance and use for projecting the lifetime fluence for a reactor pressure vessel. Strong support is thus generated for establishment of one "standard" set of basic nuclear data from which all reactor physics analysts can draw to generate specific cross sections for reactor physics calculations, and for the writing of a new reactor physics spectrum code specifically for deep penetration analysis of reactor pressure vessel walls. (auth)

51218 OUTLINE OF THE REACTOR PLANT FOR THE NUCLEAR-POWERED SHIP MUTSU. Fujinaga, Hajime (Mitsubishi Atomic Power Industries, Inc., Tokyo). Nippon Zosen Gakkaishi; No. 493, 368-76(Jul 1970). (In Japanese).

The reactor plant for the "Mutsu" is outlined. Features of the PWR plant are: total weight of UO_2, 2.77 tons; overall ratio of H_2O/UO_2, 2.30 (vol.); reactor-core life 13500 MWD; and control rods of Ag–In–Cd, 12. The following are described: arrangement of the plant, reactor core, main cooling system, reactor pressure vessel, steam generator, pressurizer, volume control system, cooling system for the auxiliary equipment, remaining-heat removal system, emergency cooling system, sampling system, waste treatment system, reactor control and instrumentation, and reactor shutdown system. (Japan)

51219 NETHERLANDS: BILL ON THE LIABILITY OF OPERATORS OF NUCLEAR SHIPS. Nucl. Law Bull., Suppl.; No. 7, 1-12(Apr 1971).

Regulations concerning the liability for damage from nuclear incidents involving ships with nuclear power plants are presented. (H.D.R.)

Production Reactors

51220 CLOSED-LOOP COMPUTER CONTROL OF SAVANNAH RIVER REACTORS. Gimmy, K. L. (E. I. duPont de Nemours and Co., Aiken, S. C.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 31-2(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51221 PILOT: AN ON-LINE COMPUTER SUPERVISORY SYSTEM FOR REACTOR CONTROL. Hurley, T. J. Jr. (E. I. duPont de Nemours and Co., Aiken, S. C.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 32-3(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51222 COMPUTERIZED TESTING OF REACTOR SYSTEMS. Worster, L. D. (Douglas United Nuclear, Inc., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 36-7(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51223 EMERGENCY CORE COOLING STUDIES: SAVANNAH RIVER REACTORS. Thornberry, R. C. (E. I. duPont de Nemours and Co., Aiken, S. C.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 40-1(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51224 ACTIVITY CONFINEMENT AND DECONTAMINATION AFTER FAILURE OF AN ANTIMONY–BERYLLIUM SOURCE ROD. Joseph, J. Walter Jr.; Little, John W. Jr. (E. I. duPont de Nemours and Co., Aiken, S. C.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 43-4(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51225 HANFORD RECERTIFICATION IN RESPONSE TO NEW AEC DIRECTIVES. Edwards, T. E. (Douglas United Nuclear, Inc., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 50(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

Reactor Theory

51226 (JAERI–13507) EVALUATION ON GROUP CONSTANT OF PLUTONIUM. Sakata, Hajime; Kawashima, Kanau; (and others) (Japanese Nuclear Data Committee). Mar 1969. 67p. NTIS (U. S. Sales Only).

For evaluation on group constants of plutonium isotopes, analyses of experiment data were performed by using the JNDC (Japanese Nuclear Data Committee) library set. The JNDC set is composed of THERMOS and MUFT type libraries and is produced by the reactor constant sub-group in JNDC based on BNL-325 2nd ed. suppl. No. 2 and Aldermaston/Winfrith (A/W) nuclear data. Experimental data used are selected from experiments for the PuO_2–UO_2 fueled-H_2O moderated lattices with variation of plutonium enrichment, isotopic composition of plutonium and lattice spacing. The accuracy of criticality calculations is fair, but the values are generally smaller than experimental ones. For comparison the analyses were performed by using libraries prepared at several organizations. (auth) (Japan)

51227 (JAERI–13515) MEASUREMENT OF THERMAL NEUTRON SPECTRA IN H_2O POISONED WITH Cd AND In. Kaneko, Yoshihiko; Akino, Fujiyoshi; (and others) (Japan Atomic Energy Research Inst., Tokai). Apr 1969. 26p. NTIS (U. S. Sales Only).

Neutron spectra in a H_2O slab poisoned with In and Cd were measured by the time of flight method using a 20 MeV LINAC. This spectrum source is a simulation of the plutonium deposited core of a commercial light water reactor due to a burnup of 15000 MWD/T. It is suggested from the experimental results that a rigorous treatment for resonance neutron captures and thermal neutron scatterings must be essential in the calculation of the neutron spectra in such cases. (auth) (Japan)

51228 (JAERI–13711) PRINCIPLE OF EXPERIMENTAL METHOD TO DETERMINE MIGRATION AREA IN REFLECTED REACTOR. Kaneko, Yoshihiko; Akino, Fujiyoshi (Japan Atomic Energy Research Inst., Tokai). Sep 1969. 7p. NTIS (U. S. Sales Only).

A principle of the experimental method is proposed to determine the migration area in a reflected cylindrical reactor by the pulsed neutron technique. The advantageous point of this method over the earlier ones is that the slowing down length can be determined as well as the migration area in a form taking into account their anisotropy. (auth) (Japan)

51229 AMERICAN NATIONAL STANDARD DOSIMETRY FOR CRITICALITY ACCIDENTS. ANSI N13.3 1969. New York; American National Standards Institute, Inc. (1969). 16p. Available from American National Standards Institute, New York.

Presented are criteria applicable to operations with fissionable materials in which accidental criticality may occur and cause the exposure of personnel to acute, external, and penetrating radiation doses exceeding the maximum doses recommended for normal practice. The dosimetry systems covered by the standard are those capable of providing dose information down to about 10 rad. The standard provides criteria for a system capable of measuring the doses received by personnel involved in a criticality accident. Systems using physical detectors, biological samples, or combinations may conform to the standard. The dose information is intended to: (1) Assist the management of exposed individuals. (2) Provide a basis for correlating man's radiation dose to his biological response. (3) Contribute to the maintenance of integrated exposure records. The standard specifies dosimetric capability and performance in

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rads. The quality factor for the conversion of absorbed dose from neutrons (rad) to dose equivalent (rem) for criticality accident is assumed to be between one and two. (auth)

Kinetics

Refer also to abstract 51026.

51230 (CISE-N-146) UNIFIED THEORY OF CELL DIFFUSION COEFFICIENTS. Bonalumi, R. A. (Centro Informazioni Studi Esperienze, Milan (Italy). Combustion Engineering, Inc., Windsor, Conn.). May 1971. 29p. (CONF-710606-11). Dep. NTIS (U. S. Sales Only).

From seventeenth annual meeting of the American Nuclear Society; Boston, Mass. (13 Jun 1971).

A cell diffusion coefficient $\tilde{D}$ in a multi-velocity formalism is so defined that, in an infinite uniform lattice with a tilted source, the net current across a (circularized) cell is the product of $\tilde{D}$ by the derivative of the macroscopic flux, taken as coincident with the true flux on the cell boundary; such a $\tilde{D}$ is then shown to coincide with the Benoist diffusion coefficient when normalized to the cell-edge rather than cell-averaged fine flux. A synthetic interpretation of the original formula is applied to a direct calculation of $\tilde{D}$ in LWR lattices; a line of development for widely spaced lattices is also indicated. The formula for $\tilde{D}$ is split up into its different contributions, the first of which (principal term) is the "mean square D", such that its ratio to cell-edge flux normalized absorption cross section gives the groupwise birth-to-death mean square distance. Blackburn's calculation of the so-called source anisotropy correction is reported. A full, diffusion theory calculation of the dipolar flux in the moderator of an infinite lattice is performed, exhibiting the correct relationship between such a flux and $\tilde{D}$. This allows a correct evaluation of the Benoist-type absorption correction to be carried out in a noniterative way. Two analytical methods for the calculation of the "mean square D" are presented in the appendices. 10 references. (auth)

51231 (INR-1296) S-III-THERMOS CODE FOR THE GIER COMPUTER. Bogumil, Stanislawa; Kowalska, Krystyna (Institute of Nuclear Research, Warsaw (Poland)). 1971. 129p. Dep. NTIS (U. S. Sales Only).

S-III-THERMOS is a code calculating thermal neutron distribution in space and energy in an elementary reactor cell. It is written in GIER-ALGOL 3 language. A description of physical models and numerical approximations used in the code, programme description and user's manual with input preparation, a test case and library of the code are included. 18 references. (auth)

51232 (JAERI-13660) EXPANDA-4: THE ONE-DIMENSIONAL DIFFUSION EQUATION CODE FOR FAST REACTORS USING THE JAERI-FAST-SET. Suzuki, Tomoo (Japan Atomic Energy Research Inst., Tokai). Jul 1969. 17p. NTIS (U. S. Sales Only).

The series of codes, named CONDENSE, LTFR-4 and EXPANDA-4, was developed for criticality calculation of fast reactors. These codes utilize the 70 group cross sections (JAERI-FAST-SET) made by the processing codes of reactor cross sections. The number of groups is decreased from 70 by condensing the cross sections so that shielding tables similar to ABN set are included because this type is convenient to use for criticality calculation. The description is given of these codes and their input format. (auth) (Japan)

51233 (JAERI-13700) IMPROVEMENTS TO THE INTERMEDIATE TREATMENT OF RESONANCE ABSORPTION IN NUCLEAR REACTOR THEORY. Ishiguro, Yukio (Japan Atomic Energy Research Inst., Tokai). Sep 1969. 108p. NTIS (U. S. Sales Only).

The new method for intermediate treatment of resonance absorption is developed in sufficiently general form that any particular approximate equation proposed for the intermediate treatment can be derived by a special approximation of the equations developed. (TSS) (Japan)

51234 (JAERI-13707) CONCEPT OF REACTIVITY AND RELATED PROBLEMS. Kaneko, Yoshihiko (Japan Atomic Energy Research Inst., Tokai). Sep 1969. 11p. NTIS (U. S. Sales Only).

The validity of the concept of reactivity is discussed after a short summary of the relation between its definition and time-eigenvalue. It is pointed out that none of the experimental methods can determine the value of the reactivity in a highly subcritical reactor. An approach to avoid the experimental difficulties is also presented. (auth) (Japan)

51235 (JAERI-13777) FUNDAMENTAL STUDY ON THERMAL REACTOR PHYSICS PROBLEMS BY PULSED NEUTRON TECHNIQUE. Kaneko, Yoshihiko (Japan Atomic Energy Research Inst., Tokai). Oct 1969. 80p. NTIS (U. S. Sales Only).

The experimental results on the time-dependent problems of neutron slowing down and thermalization in the moderators and the results on the problems of the neutron multiplication in SHE are described. The outline of the design and performance of the first domestic pulsed neutron generator, which is used throughout the experiments, is presented. The experimental results of the neutron slowing down times and thermalization time constants in graphite, water, ice, paraffin, and santowax are described. The effect of the chemical bindings in the moderator is made clear on the neutron slowing-down phenomena in the energy region below 1 eV. The theoretical and experimental works on the following items are reported: (1) subcriticality determination in highly subcritical cores; (2) compilation of the control rod effectiveness as check data for the accuracy of the calculational methods; (3) prompt neutron decay constants at critical state; (4) space dependent transfer function. (auth) (Japan)

51236 INTEGRAL TRANSPORT THEORY ANALYSIS OF CENTRAL REACTIVITY WORTH MEASUREMENTS. McGrath, P. E.; Foell, W. K. (Univ. of Wisconsin, Madison). Nucl. Sci. Eng.; 45: No. 3, 237-44 (Sep 1971).

A new collision probability formulation of integral transport theory is applied in the analysis of small-sample reactivity measurements. The calculational technique features a blending of diffusion theory, used to represent the unperturbed reactor, and integral transport theory, used to represent the sample and that portion of the reactor significantly perturbed by the sample. The theory forms the basis for a perturbation theory computer program, COPERT, which, in conjunction with the one-dimensional diffusion theory program MACH-1, has been applied to the analysis of central reactivity measurements in the ZPR-3 fast critical assembly. The method provides a convenient means of accounting for sample-size effects. (auth)

51237 USE OF LAGRANGE MULTIPLIERS FOR OPTIMIZATION OF NUCLEAR REACTORS. Sakhnovskii, E. G. This paper was summarized in At. Energ. (USSR); 29: No. 3, 201-2 (Sep 1970) as paper No. 420/5676. (In Russian).

The optimization of systems described by equations whose form changes at a certain point in the domain on the independent variable are examined. It is assumed that the functional to be minimized and the boundary conditions depend on the interior points of the indicated region, and that constraints depending on the variables of the state of the system are applied to the control functions. Such problems arise in the optimal design of nuclear reactors with reflectors when heat-engineering conditions are decisive. Auxiliary control functions are used to pass from constraints having the form of conditional inequalities to equivalent relations in the form of equalities in order to solve nonclassical problems in control theory by using classical methods from the calculus of variations. This amounts to inserting the indicated relations with the aid of Lagrange multipliers into a functional differing from the original by terms equal to zero. A transition to a more general functional is achieved. As a simple example illustrating the possibilities of the method and permitting a unique analytical solution, considered in the one-group approximation is the problem of minimizing the critical size of a slab reactor with reflector in the presence of constraints on the uranium concentration and the specific power and with given total reactor power. An exact solution to the problem is obtained: the core of the optimal model of the reactor has a central region for which the uranium concentration is determined from the condition of maximal permissible specific power, and it has peripheral regions with maximal permissible uranium concentration. (auth)

51238 STUDIES OF NUMERICAL METHODS FOR SOLVING ONE-POINT REACTOR KINETIC EQUATIONS. Koyama, Shigeo; Wakamatsu, Seiji (Electrotechnical Lab., Tokyo). Denshi Gijutsu Sogo Kenkyusho Iho; 34: No. 7, 600-14 (Jul 1970). (In Japanese).

A comparative examination is given into several numerical methods for solving one-point reactor kinetic equations. Taylor series expansion of the kinetic equations is employed to clarify the convergency of several numerical methods. It has been concluded that the numerical instability occurs mainly due to the truncation error which is inherently based on each method. Numerical examples suggest the length of the time interval "h" to be selected to perform stable and reasonably precise calculation as follows: $h \leq T_{min}$ in the 4th order Runge-Kutta method and the Runge-Kutta-Gill method; $h \leq 2T_{min}$ in the Runge-Kutta-Merson method and the 5th order Runge-Kutta method; where T_{min} is the minimum time constant of a set of kinetic equations. (auth)

51239 UNIFIED THEORY OF CELL DIFFUSION COEFFICIENTS. Bonalumi, R. A. (CISE, Milan). Energ. Nucl. (Milan); 18: No. 7-8, 393-407 (Jul-Aug 1971).

A new operating definition of the radial diffusion coefficient for a cell is presented. The definition clarifies what gross flux must be used, and respects Selengut's equivalence principle. The coefficient thus obtained is shown to be equivalent to the cell edge-flux normalized value of Benoist's diffusion coefficient. A complete account of the calculation of absorption-related corrections to the mean-square diffusion coefficient is given, along with a corrected version of the relationship between such quantity and the tilted flux in a lattice. A generalized equivalence method and close approximations to some Benoist functions are given for practical calculations. 10 references. (auth)

Dynamics

51240 STABILITY DOMAINS IN NONLINEAR POINT REACTOR DYNAMICS. Kendall, James Michael. Tucson, Ariz.; Univ. of Arizona (1971). 55p. University Microfilms Order No. 71-13,476.

Thesis.

The nonlinear point reactor kinetics model with linear reactivity feedback is studied to determine stable regions of the state space. Geometric and Liapunov techniques are used to determine system stability and effects of system parameters on the stable region. In studying the one temperature region model with effective lifetime kinetics and a power coefficient, a transformation is obtained which simplifies analysis of the system. Using this transformation an exact solution is found for parameter values such that the system is a nonlinear center. In addition, a Liapunov function is developed which proves asymptotic stability for an infinite sector of the phase space. The stable region shown by this method is compared to those shown by previous techniques for a given set of parameters. In applying the method to the two temperature region model with effective lifetime kinetics, a set of trajectories asymptotically approaching lines of constant reactivity is shown to exist. An infinite region bounded by three intersecting planes with the property that all trajectories crossing the planes move toward the interior of the region is determined. The parameter condition required for existence of this region is shown to be identical to the condition for the existence of stable limit cycles stated in a previous paper. Numerical examples studied indicate the region described above is one of bounded trajectories, i.e., all trajectories with finite initial conditions within the region remain bounded. Possible applications of the method to higher order systems are discussed. Preliminary studies indicate a set of trajectories asymptotic to lines of constant reactivity exists for these models, and that this set may be of assistance in an attempt to define regions of stability. (Diss. Abstr. Int., B)

51241 NONLINEAR OSCILLATIONS AND STABILITY BOUNDS IN A NUCLEAR REACTOR WITH LINEAR REACTIVITY FEEDBACK. Yee, Samuel. Tucson, Ariz.; Univ. of Arizona (1971). 139p. University Microfilms Order No. 71-13,482.

Thesis.

Systems of autonomous nonlinear differential equations describing the stability of a nuclear reactor with two reactivity feedbacks were analyzed to determine stability bounds. The system parameters used are representative of a fast reactor with in-core thermionic converters. A property common to all fast reactors is the possibility of one positive temperature coefficient which complicates control problems. This study may have application in the solution of such problems. Oscillation boundaries of the linearized system are established as an aid to the controls designer and to provide preliminary information in nonlinear stability analysis. Bounded regions are determined for the effective lifetime model and coupled temperature equations by means of computer surveys of exact solutions. Bounded regions are determined for the prompt jump model and essentially the same results and conclusions are obtained as for the effective lifetime model. An analytical (perturbation expansion) method is presented and applied to the effective lifetime model and coupled temperature equations. (Diss. Abstr. Int., B)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 48691, 49205, 49343, 49344, 49346, 49350, 49356, 49358, 49360, 49372, 49373, 49376, 49377, 49386–49388, 49432, 49487, 49489, 49493, 49507, 49509, 49510, 49522, 49532, 49570, 49571, and 49581.

51242 (GEAP-12205) TRITIUM DISTRIBUTION IN HIGH POWER ZIRCALOY FUEL ELEMENTS. Grossman, L. N.; Hegland, J. O. (General Electric Co., Pleasanton, Calif. Vallecitos Nuclear Center). Jun 1971. Contract AT(04-3)-189. 42p. Dep. NTIS.

Tritium distributions have been determined for the fuel and cladding of two ~½ inch diameter Zircaloy-2-clad UO_2 fuel elements. Rod CP-206 obtained an average burnup of 12,000 MWd/Te at an average maximum linear power of 17.6 kW/ft; 75% of the tritium was released from the fuel. Rod 12FV obtained average burnup of 21,000 MWd/Te at an average maximum linear power of 31.4 kW/ft; 96% of the tritium was released from the fuel. A correlation between tritium release and power density was obtained. The results of neutron radiography, ceramographic examinations, gamma activity profiles, burnup and fission analyses, puncture gas analyses (including fission gas isotopes) and vacuum outgas analyses of the claddings are also given. Tritium was distributed nonuniformly in the cladding; hydrogen, from general corrosion was uniformly distributed. Thermal diffusion of tritium toward fuel-free regions was indicated in the cladding of Rod 12 FV which was irradiated in a pressurized water loop with larger lineal thermal gradients along the cladding. 18 references. (auth)

51243 (JAERI-13616) VIBRATION OF FUEL RODS IN THE TLG-1-50 IN-PILE GAS LOOP. Yokoo, Hiroshi; Kumagai, Katsuaki; (and others) (Japan Atomic Energy Research Inst., Tokai). Jun 1969. 46p. NTIS (U. S. Sales Only).

An experimental study was made in order to evaluate the vibration of the fuel rod assembly to be irradiated in the TLG-1-50 In-pile Gas Loop. The vibration frequency and amplitude of several simulated fuel rods were measured under various flow conditions of helium gas at room temperature, varying the coolant velocity from 0 to 24 m/sec and the gas density from 0.8 to 1.3 kg/m^8. The simulated rods, consisting of the lead meat cladded in the stainless steel can, have dimensions of 10 mm × 230 mm. The experiment covers the range of the weight per unit length from 6.2 to 8.6 g/cm and the flexural rigidity from 2.8 to 9.8 $kg\text{-}m^2$ which cover the representative characteristics of the fuel rods under irradiation at high temperature. It was found that the vibrating frequency is almost independent of the flow conditions indicating the natural frequency of the rod. It was also found that the amplitude is approximately proportional to the hydrodynamic force of the fluid. From these facts, an empirical equation was derived. By the formura, the vibration stress of the fuel rods was evaluated for high temperature conditions in the in-pile loop. The stress was so small that at any normal operations of the TLG-1-50 no fatigue failure could occur in this type of fuel rod assembly. (auth) (Japan)

51244 (JAERI-13670) STUDIES OF FISSION PRODUCT RELEASE IN TLG-1 IN-PILE GAS LOOP. 1. Irradiation Test of Leaky Fuel. Kitahara, Tanemichi; Shirai, Eiji; (and others) (Japan Atomic Energy Research Inst., Tokai). Aug 1969. 48p. NTIS (U. S. Sales Only).

A series of experiments were carried out on the fission product release behavior of various types of leaky fuel elements using an inpile gas loop, TLG-1. The results obtained in the early stage of the program in which an NaI(Tl) scintillation counter was used for the gamma-ray spectrum measurements are presented. Two kinds of fuel specimens were irradiated, a sheet of U–Al foil without sheathing tube and sintered UO_2 pellets contained in a pinholed sheath. Gamma-ray spectra obtained were much different between the two types of specimens. The short lived fission gases were observed in the former specimen, while they were not in the latter. Most short lived fission gases are considered to have decayed during the trip via the pinhole in the latter specimen. Some of the problems are also discussed, which are specific to the fission product release experiment made in a closed loop system such as TLG-1. (auth) (Japan)

51245 (JAERI-13750) REPORT ON FUEL IRRADIATION TESTING AT HBWR, NO. 3. Status of IFA-106, -149, and -150 Irradiation During the Period of Nov 1968–May 1969 in HBWR. Ichikawa, Michio; Takebayashi, Monya; (and others) (Japan Atomic Energy Research Inst., Tokai). Oct 1969. 41p. NTIS (U. S. Sales Only).

The analysis of the data obtained from IFA-106, -149 and -150 during the period of Nov. 1968 ~ May 1969 is described. The IFA's have been satisfactorily operating, and the maximum burnup obtained about 10,000 MWD/T (IFA-106). The center temperature of the fuel pins measured by W/Re–W/Re thermocouple shows good agreement with the calculated temperature. The measured fission gas pressure shows rapid increase after 5,000 MWD/T burnup. The mechanical interaction between UO_2 pellet and Zircaloy-2 sheath deduced from the fuel pin elongation detector occurs at lower fuel heat rating than the calculated and the threshold heat rating at which interaction begins decreased as the burnup increases. (auth) (Japan)

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51246 (JAERI-Memo-4351) ANALYSIS OF CONTROL ROD EFFECTIVENESS BY NORDHEIM-SCALETTAR METHOD. II. Inoue, Shuji; Akino, Fujiyoshi (Japan Atomic Energy Research Inst., Tokyo). Jan 1971. 29p. (In Japanese). Dep. NTIS (U. S. Sales Only).

A computer code is described based on the Nordheim-Scalettar method for calculating the effectiveness of multiple cylindrical control rods absorbing fast and thermal neutrons while being partially or fully inserted into the core or reflector regions of cylindrical reactors. The calculated values were compared to the measured values by pulse neutron technique for black B_4C control rods in SHE. The accuracy of the calculation is within 10% for fully and/or partially inserted multiple control rods. (auth)

51247 (JUL-747-RW) IRRADIATION BEHAVIOR OF DIFFERENT ASSEMBLIES OF REACTOR GRAPHITE. Delle, Wolfgang (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Apr 1971. 91p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Technische Hochschule, Aachen, Ger.

Various reactor graphites were studied with respect to type of grain, type of binder, and amount of binder. The physical properties investigated were dimensional changes, porosity, elasticity modulus, stress resistance, specific electrical resistance, specific heat conductivity, and linear thermal expansion. Results showed that a close correlation exists between the changes of various physical properties which predominantly originated in crystalline processes. (110 references) (H.B.G.)

51248 REDUCING EFFECTS OF GROUNDS ON CRITICAL REACTOR CONTROL CIRCUITS. Neumayer, E. C. (Douglas United Nuclear, Inc., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 5(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51249 NEW REACTOR PROTECTION SYSTEM. Howard, R.; Geesey, A.; Schultz, M. A. (Pennsylvania State Univ., University Park). Trans. Amer. Nucl. Soc.; 14: Suppl. 2, 35-6(1971).

From Conference on reactor operating experience; Denver, Colo. (8 Aug 1971). See CONF-710808.

51250 SOME STRUCTURAL CONSIDERATIONS IN THE DESIGN OF NUCLEAR CONTAINMENT LINERS. Doyle, J. M. (Univ. of Illinois, Chicago); Chu, S. L. Nucl. Eng. Des.; 16: No. 3, 294-300(1971).

The evaluation of forces and deformations of liner plate anchors in containment structures is studied. These forces and deformations are due to buckling, and hence reduction in load carrying capacity, of a panel of the liner plate. Specifically, the behavior of headed stud and of continuous rib type anchors is investigated. The stiffness characteristics of the anchors are based on experimental evidence and are nonlinear. Parameters which are varied include the plate thickness, yield stress, and anchor spacing. The results of several representative configurations are presented from which behavior trends can be observed. It is found that an increase in yield stress of an amount often encountered in practice causes a large increase in anchor force and deformation. On the other hand, a plate thickness increase of 15% results in a much smaller increase of anchor force and displacement. 7 references. (auth)

51251 DELAYING RADIOACTIVE FISSION PRODUCT INERT GASES IN COVER GAS AND OFFGAS STREAMS OF REACTORS BY MEANS OF ACTIVATED CHARCOAL DELAY LINES. Foerster, K. (INTERATOM, Bensberg, Ger.). Kerntech. Atomprax.; 13: No. 5, 214-19(May 1971). (In German and English).

The removal of radioactive inert gases from cover gas or offgas streams of reactors is a difficult problem because sufficient decontamination can be achieved virtually only by physical means. A proven method for achieving a decay of radioactivity is to delay the fission gases relative to the carrier gas by means of activated charcoal. The principle of activated charcoal delay lines is described. Experiments which were carried out to measure directly the delay times achievable with various types of activated charcoal are reviewed. As these experiments took into account all the important parameters concerned, the results obtained provide a basis for the optimal design of delay facilities. (auth)

51252 DEMOUNTABLE COVER FOR A PRESTRESSED CONCRETE VESSEL. Costes, Didier; Puyo, Andre (to Commissariat a l'Energie Atomique). British Patent 1,223,638. 3 Mar 1971. Priority date 8 Sep 1967, France.

A cover for a prestressed concrete vessel is designed which facilitates the opening of the central obturator. The cover has peripheral blocks arranged around the central obturator and clamped radially thereon by tensioned rings. The obturator comprises several superjacent slabs applied on to one another by longitudinal prestressing cables. Details of the design and opening operation are given. (D.L.C.)

51253 NEARLY MONOCHROMATIC γ BEAM OF VARIABLE ENERGY. Fagot, J.; Lucas, R.; Nifenecker, H.; Schneeberger, M. (CEN, Saclay, France). Nucl. Instrum. Methods; 95: No. 3, 421-7(1971). (In French).

A facility for producing a variable energy gamma ray beam by neutron capture gamma rays is described. The beam of desired energy is produced by Compton scattering of the 6.75 MeV titanium gamma rays. By exciting nuclear energy levels through the resonance fluorescence process the lifetime of these levels can be determined. The apparatus has been tested by measuring the lifetime of the 3.560 MeV and 4.433 MeV in ^6Li and ^{12}C, respectively. The results are in agreement with previous measurements. (auth)

51254 NUCLEAR FUEL VENTING ELEMENTS FOR THE DISCHARGE OF FISSION GASES. Cambell, Ronald Hugh (to United Kingdom Atomic Energy Authority). U. S. Patent 3,573,168. 30 Mar 1971. Priority date 16 May 1967, Great Britain.

To allow decay of some of the gaseous fission products produced from nuclear fuel under irradiation before discharge of said products from the interior of a nuclear reactor fuel element of the vented type to the exterior surroundings of the fuel element, there is included within the fuel element a passage-defining component such as a capillary tube, an external surface of which defines an additional passage in series with the passage defined by the component, the two passages together providing a vent path for gaseous fission products. Alternatively or in addition, tubing in communication with the interior of the fuel element extends at least in part over the external surface of the fuel element and provides a vent path or additional vent path. Such tubing may be in the form of a capillary tube coiled over said surface which serves also for fuel element spacing and to improve heat transfer to coolant flowing over the fuel element. (Offic. Gaz.)

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GENERAL

51255 (AEC-tr-7262) STUDY OF LONGITUDINAL SHOCK WAVES OF FINITE AMPLITUDE IN NONLINEAR ELASTIC MATERIALS STARTING FROM THE SYSTEM OF ISENTROPES. de Belloy, Jean Boistel. Translated by Anna Vakar for Sandia Labs., Albuquerque, N. Mex., from J. Mec.; 9: No. 2, 277-307 (1970). 41p. Dep. NTIS.

51256 (ANL/ES-CC-9) CHICAGO AIR POLLUTION SYSTEMS ANALYSIS PROGRAM. Final Report. (Argonne National Lab., Ill.). Feb 1971. Contract W-31-109-eng-38. 393p. Dep. NTIS.

51257 (BDX-613-205(Rev.)) MACHINE COOLANT SELECTION AND MAINTENANCE MANUAL. Lyons, V. A. (Bendix Corp., Kansas City, Mo.). Nov 1970. Contract AT(29-1)-613. 83p. Dep. NTIS.

51258 (BDX-613-386) MOISTURE CONTENT STUDY OF Y-3333 CELLULAR SILICONE. Interim Report. Edman IV, G. W. (Bendix Corp., Kansas City, Mo.). Jul 1971. Contract AT(29-1)-613. 20p. Dep. NTIS.

51259 (BDX-613-390) STUDY OF THE FUNCTIONAL CAPABILITIES OF AN AIR-BEARING COMPRESSION TEST FIXTURE. Interim Report. Martinette, G. E. (Bendix Corp., Kansas City, Mo.). Jul 1971. Contract AT(29-1)-613. 15p. Dep. NTIS.

51260 (BDX-613-391) STUDY OF THE FUNCTIONAL CAPABILITIES OF A TOTAL AREA LOADING COMPRESSION TEST FIXTURE. Interim Report. Martinette, G. E. (Bendix Corp., Kansas City, Mo.). Jul 1971. Contract AT(29-1)-613. 15p. Dep. NTIS.

51261 (BDX-613-402-S) ELECTRICAL CONTACT SURFACE TREATMENT. Williams, G. A. (Bendix Corp., Kansas City, Mo.). May 1971. Contract AT(29-1)-613. 38p. Dep. NTIS.

51262 (BDX-613-412) REFERENCE ELECTRODE AND ITS USE IN DETERMINING INDIVIDUAL ELECTRODE POTENTIALS. Klingsporn, P. E. (Bendix Corp., Kansas City, Mo.). Jul 1971. Contract AT(29-1)-613. 31p. Dep. NTIS.

51263 (BDX-613-427) ELECTRICAL TERMINATIONS: WELDED, BRAZED, AND BONDED. Quarterly Report, FY 71-3. Stittsworth, D. E. (Bendix Corp., Kansas City, Mo.). Jul 1971. Contract AT(29-1)-613. 67p. Dep. NTIS.

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51357 INTERNATIONAL SYMPOSIUM ON MACROMOLECULAR CHEMISTRY, TORONTO, SEPTEMBER 3–6, 1968. St. Pierre, L. E. (ed.). J. Polym. Sci., Part C; No. 30, 1-718 (1970). (In English and French). (CONF-680966).

Seventy-one papers are included in this volume from a total of 5 plenary lectures, 33 symposium lectures, and 233 contributed papers. The focal area of the conference was upon physical properties of polymers; a second emphasis was upon the structure and function of bipolymers. The 72 papers are grouped here under the following sections: (I) Thermodynamics and Conformations of Macromolecules in Solution (15 papers); (II) Structure of Macromolecules (5 papers); (III) Electrical Properties—Conduction and Relaxation Processes (8 papers); (IV) Plastic Deformation and Structure of Crystalline Polymers (9 papers); (V) Adsorption of Polymers (4 papers); (VI) Structure, Rheology, and Mechanical Properties of Composites (12 papers); (VII) Cellulose—Hemicellulose and Lignins (4 papers); (VIII) Organic Glasses (3 papers); (IX) Structure and Function of Biopolymers (11 papers). A separate abstract was prepared for one paper, "Conduction in Polymers," by W. L. McCubbin. (L.M.T.)

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Germanic	ä	appears as ae
Germanic	ö	oe
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SUBJECT INDEX

Cross references are included in cumulative subject indexes and in *Subject Headings Used by the USAEC Division of Technical Information* (USAEC report TID-5001).

The reader is also referred to *Guide to Abstracting and Indexing for Nuclear Science Abstracts* (USAEC report TID-4576).

Most headings in the subject index are specific materials, things, and processes. The headings are followed by modifiers that describe the properties of, or processes applied to, the headings.

All index entries cite *NSA* volume and abstract numbers; volume number precedes the colon and the abstract number follows it. The designation (R) following the abstract number indicates a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. Report numbers, where applicable, are included in parentheses after the abstract number of the citation. Published literature (journal article or book) can be identified by the absence of a report number.

Ideas presented in the original literature, rather than key words, have been indexed. The indexers have selected what seemed the most probable and logical place to look for typical information. Since it is not always possible to anticipate where a user would look for information, the cumulative indexes include numerous cross references. Consideration of synonymous or closely related terms will prove valuable.

Information is indexed for the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use or to the general class headings that include the specific headings. For example, information on boiler design for the Fermi Fast Breeder Reactor would be indexed under the headings BOILERS and FERMI FAST BREEDER REACTOR but not necessarily under the headings REACTORS, FAST or REACTORS, BREEDER.

General or broad headings are reserved for general summaries, reviews, comprehensive reports, and similar literature.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings; e.g., AMINO ACIDS rather than ACIDS, AMINO; HELIUM ISOTOPES He-4 rather than HELIUM—ISOTOPES He-4 or HELIUM—He-4 ISOTOPES. Note, however, that in some cases parenthetic modifying terms or inverted headings such as NEUTRONS, FAST, are used where the alphabetical arrangement of a direct entry would cause information to be scattered. In addition, organic compounds are usually entered in the index in the inverted form to facilitate grouping like or related compounds with the parent compounds; e.g., BENZENE, BROMO- rather than BROMOBENZENE. In general, the nomenclature used is that of the subject indexes to *Chemical Abstracts*.

Alphabetization

Subject headings are alphabetized word by word. Parenthetic qualifiers, numbers, and Greek letters within subject headings are disregarded in alphabetizing unless there are two or more headings that are otherwise identical, in which case the qualifier, numerical progression, or spelled names for the Greek letters determine the order.

Examples:

M-Capture
  see ELECTRON CAPTURE
MAGNESIUM
MAGNESIUM ALLOYS AND SYSTEMS
MANGANESE FLUORIDES
MANGANESE FLUORIDES MnF_2
MESONS
MESONS (π)
MESONS (ρ)
1-PENTANOL
2-PENTANOL

Modifying Phrases

The modifiers appearing under a subject heading are written specifically to show the relation between the item being indexed and the heading. The modifier therefore contains a maximum of useful information. Although the modifier begins with the word judged to be of greatest use to the greatest number of users, there is still need for the searcher to consider all modifiers under the heading(s) of interest.

Modifiers usually form meaningful phrases when combined with the subject heading. Some are intended to be read following the subject heading, e.g., the entry HYDROGEN—sorption by charcoal should be read "hydrogen sorption by charcoal." As a result of placing the important word first, however, many modifiers must be rearranged for smooth reading, e.g., FORMALDEHYDE—yields in radiolysis of ethyl ether, effects of deuterium on, should be read "effects of deuterium on formaldehyde yields in radiolysis of ethyl ether" and URANIUM—crystal structure of, effect of cooling rate on allotropic transformations in, should be read "effect of cooling rate on allotropic transformations in crystal structure of uranium."

Special characters are added to modifiers in the fields of physics and reactor technology; if the modifier does not establish the experimental or theoretical character of a reference, a symbol (E), (T), or (E/T) is placed immediately after the modifying phrase and before the abstract number.

XUM

Physical States and Configurations of Materials

The specific physical state, if other than normal, or the geometric configuration of the material is included in the modifying phrase; e.g., information on liquid metals is indexed under the specific metal with "liquid" in the modifier and carbon crucibles is indexed under CARBON with "crucibles" appropriately placed in the modifier. The information on carbon crucibles is also indexed under CRUCIBLES.

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed to subject headings in the direct form. Cations are listed in the order of increasing valence for polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., SODIUM ALUMINUM SILICATES and POTASSIUM SODIUM SULFATES. If more than one anionic species is presented in a compound, the anions are arranged alphabetically, e.g., BERYLLIUM FLUORIDE HYDROXIDES.

Nomenclature of Organic Compounds

Organic compounds are indexed by subject headings based on the indexes to *Chemical Abstracts* except in the area of enzymes, in which specific enzymes, named according to the 1964 recommendations of the International Union of Biochemistry, are used. In many cases nonproprietary names for drugs are used as subject headings, and cross references are made from the systematic chemical names. Subject headings for hormones appear in the inverted style at HORMONES.

Nomenclature of Life Sciences

Subject headings for plants are names of phyla with one exception: members of the Phylum Tracheophyta are indexed under class or subclass names. Scientific names (genus and species) are used as the initial, or file, word in the modifying phrase. Scientific names are omitted only when the name is not available in the literature or cannot be found in available references.

Subject headings for animals are the names of phyla with the following exceptions: (1) members of Phylum Arthropoda and Phylum Chordata are indexed under appropriate class name, and (2) common names are used for members of Class Mammalia.

Subject headings are entered for various classes of commodities, and specific products are identified in the file-word position of the modifier. In the following examples, approved subject headings are capitalized and typical modifier file words are listed in lower case.

Example 1	Example 2
CEREALS	MEATS
bread	beef
flour	fish
oats	mutton
rice	pork
rye	poultry
wheat	seafood

Diseases, pathological conditions, and in vitro studies of atypical cells and tissues are indexed under subject headings for the organism affected, under the appropriate anatomical structure of physiological phenomenon affected, and under the appropriate disease heading. Subject headings for diseases (defined as any deviation from the norm) are DISEASES; DISEASES, INFECTIOUS; DISEASES, NEOPLASTIC; DISEASES, PHYSIOLOGICAL; DISEASES, PLANT; and DISEASES, TRAUMATIC.

Diseases of mixed etiology are treated in the following manner: neoplastic diseases that are also classified as infectious or physiological are indexed under DISEASES, NEOPLASTIC; diseases in which a microorganism is the etiologic agent are classified under DISEASES, INFECTIOUS; physiological anomalies that are neither neoplastic nor infectious are indexed under DISEASES, PHYSIOLOGICAL; the acute radiation syndrome, nonspecific radiation injuries, trauma, and wounds or incisions inflicted mechanically are indexed under DISEASES, TRAUMATIC.

Specific diseases or pathological conditions are named in the file-word position of the modifier, in the author's terminology, and are set off from the remainder of the modifier by commas. Neoplasms are designated as benign or malignant in the file-word position when more specific information is not available.

Multicomponent Alloys and Other Systems

Multicomponent alloys and systems, except well-known trade names, are indexed under a subject heading for each component in the form "element systems" for nonmetals or "element alloys and systems" for metals. The modifier begins with element symbols for each component arranged alphabetically. In addition, if significance is placed on the base metal of the alloy, this is indicated by adding "-base" to the element symbol.

Example: A 1.5C, 12Cr, 0.25V, 0.8Mo, bal Fe alloy is indexed as

```
CARBON SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
CHROMIUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V,...
IRON ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
MOLYBDENUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
VANADIUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
```

Well-known alloys, such as ZIRCALOY-2, are indexed under the trade name; cross references from each component of the alloy to the trade name appear in cumulative indexes.

Multicomponent systems in which nonmetallic elements are present in large percentage and which are commonly referred to as systems or mixtures are indexed in a manner similar to alloys.

Example: A tungsten–silicon preparation is indexed as

```
TUNGSTEN ALLOYS AND SYSTEMS
  Si--W, ...
SILICON SYSTEMS
  Si--W, ...
```

Multicompound systems and mixtures of inorganic compounds are indexed under the subject heading for each component compound; the modifiers begin with an alphabetical listing of compound formulas.

Example: A lead titanate–lead zirconate mixture is indexed as

```
LEAD TITANATES
  PbTiO3--PbZrO3
LEAD ZIRCONATES
  PbTiO3--PbZrO3
```

A mixed system of compounds and elements is indexed by a combined form of the preceding conventions; e.g., a dispersion of copper and alumina would be indexed as

ALUMINUM OXIDES
  Al_2O_3--Cu, ...
COPPER ALLOYS AND SYSTEMS
  Al_2O_3--Cu, ...

Mixtures of organic compounds are indexed under subject headings for each component of the mixture; the modifiers begin with an alphabetical listing of compound names.

Example:

ACETIC ACID
  acetic acid--BF_3, ...
BORON FLUORIDES
  acetic acid--BF_3, ...

Example:

BENZENE, CHLORO-
  bromophenol--chlorobenzene, ...
PHENOL, BROMO-
  bromophenol--chlorobenzene, ...

If modifiers for alloys and systems are included with other modifiers under the same subject heading, they are filed last.

Example:

CARBON SYSTEMS
  deposition on nuclear fuel particles
  molecular structure of
  neutron total cross section for
  sorptive properties for xenon
  Young's modulus for
  Al--C--Cr, superconductivity in
  B--C, phase studies for
  C--U--Zr, fabrication and physical properties of

Nomenclature of High Energy Physics

Information on particle-particle events is indexed under subject headings for the specific particles involved. The modifier file word *interactions* is followed by the specific interaction written in symbolic form. Particle nomenclature and symbols follow that of Rosenfeld, et al. *Data on Particles and Resonant States,* UCRL-8030 (latest revision). For consistency the incident particle is always written first. The mass (in MeV) of a resonance state is included in parentheses after the symbol to avoid ambiguity. Hyperfragments are indicated in modifiers as in the following examples: Λ-He^5, Σ-H^3, $\Lambda\Lambda$-Be^{10}. The superscript on the right indicates the total number of baryons in the composite system.

Examples:

MESONS (π^-)
  interactions $\pi^- + p \rightarrow \Lambda + K^+ + \pi^-$ at 6 GeV/c in hydrogen bubble chamber, $\Lambda K(1700)$ enhancement in, (E)
BARYONS, RESONANCE (N^*)
  production of $\Delta^{++}(1236)$ and $\Delta^0(1236)$ from $K^- + p \rightarrow K^- + p + \pi^+ + \pi^-$ interactions at 2.63 and 2.70 GeV/c, (E)
HYPERFRAGMENTS
  binding energy of $\Lambda\Lambda$-He^6, three-body α--Λ--Λ model for

Subject headings are also provided for specific models and theories.

Examples:

ELEMENTARY PARTICLE MODELS (TRIPLET)
  hadron total cross sections in quark, numerical analysis of
CURRENT ALGEBRA
  PCAC hypothesis for A_1 and rho dominance in $\pi \rightarrow e + \nu + \gamma$ decay
REGGE POLE THEORY
  predictions for polarization in $K^- + p \rightarrow$ anti $K^0 + n$, $\pi^- + p \rightarrow \pi^0 + n$, and $\pi^- + p \rightarrow$ eta + n interactions at high energies
SYMMETRY GROUPS
  SU(2) × SU(4) intermediate-coupling model for nucleon and hyperon isobars

Nomenclature of Reactor Technology

Subject headings for reactors are of three types:

(1) Specific reactors, e.g., ARGONNE RESEARCH REACTOR, SAXTON POWER REACTOR

(2) Reactors having a common physics or engineering characteristic, e.g., REACTORS, FAST; REACTORS, ORGANIC-COOLED; REACTORS, PRESSURIZED-WATER

(3) Reactors having a common purpose, e.g., REACTORS, POWER; REACTORS, RESEARCH

Information on specific reactors, type (1), is indexed under the one specific subject heading. Information on classes or types of reactors, types (2) (characteristics) and (3) (purpose), is indexed under all applicable headings. For example, information on a heavy-water-moderated organic-cooled power reactor is indexed under REACTORS, HEAVY WATER-MODERATED; REACTORS, ORGANIC-COOLED; and REACTORS, POWER.

Subject headings exist for selected reactor components, e.g., REACTOR FUEL ELEMENTS. When applicable, headings for components are indexed even though they may have been included in a modifier under a type (1) or (2) heading. The materials in reactor components are indexed when the information is peculiar to the material.

Modifier file words under reactor headings are of two primary types: one type expresses reactor characteristics, e.g., reactivity; the other, components, e.g., control rod. If no subject heading appears for a reactor component, the heading REACTORS is used, and the component is used as the modifier file word.

XUM

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6 25-51009 See DOCKET-50400-6
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